DEPLOYMENT GUIDE FOR MICROSOFT AZURE— SHARED DESIGN MODEL

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Purpose of This Guide

This guide provides design and deployment details for Palo Alto Networks® Security Operating Platform on Microsoft Azure. This deployment guide focuses specifically on the shared design model. Details for the scaled design model are included in a separate deployment guide.

This deployment guide:

- Provides architectural guidance and deployment details for using Palo Alto Networks next-generation firewalls to provide visibility, control, and protection to your applications built on Microsoft Azure.
- Requires that you first read the Reference Architecture Guide for Azure. The reference architecture guide provides architectural insight and guidance for your organization to plan linkage of pertinent features with the next-generation firewall in a scalable and highly available design.
- Provides decision criteria for deployment scenarios, as well as procedures for programming features of Microsoft Azure and the Palo Alto Networks VM-Series next-generation firewall in order to achieve an integrated design.
- Focuses specifically on the shared design model. Details for the scaled design model are included in a separate deployment guide.

OBJECTIVES

Completing the procedures in this guide, you can successfully deploy a Palo Alto Networks VM-series next-generation firewall in the Azure environment. The main objectives are to enable the following functionality:

- Protection and inspection of flows inbound from the internet, outbound and east-west from private networks and for secure communication with on-premise devices
- Application layer visibility and control for all flows
- Preparing the firewalls to participate in the full Security Operating Platform with WildFire® analytics, URL filtering, identity-based services, and the full Threat Prevention services
- Resilient and scalable operation through integration with Azure load-balancer
- Panorama™ centralized management using templates and device groups
- Centralized reporting with Palo Alto Networks cloud-delivered Logging Service
- Automatic firewall configuration through bootstrapping

AUDIENCE

This deployment guide is written for technical readers, including system architects and design engineers, who want to deploy the Palo Alto Networks Security Operating Platform within a public cloud datacenter infrastructure. It assumes the reader is familiar with the basic concepts of applications, networking, virtualization, security, and high availability, as well as a basic understanding of network and data center architectures.

To be successful, you must have a working knowledge of networking and policy in PAN-OS®.

RELATED DOCUMENTATION

The following documents support this deployment guide:

- Palo Alto Networks Security Operating Platform Overview—Introduces the various components of the Security Operating Platform and describes the roles they can serve in various designs.
- Reference Architecture Guide for Azure—Presents a detailed discussion of the available design considerations and options for the next-generation VM-Series firewall on Microsoft Azure. If you are unable to access the URL for the reference architecture guide, please ask your account team to assist you.

Deployment Overview

There are many ways to use the concepts discussed in the Security Operating Platform on Azure Design Guide to achieve an architecture that secures applications deployed on Azure. Each of the design models in the design guide provide an example architecture that secures inbound access to an application in Azure, the communication between private virtual machines and workloads, and the connection to your on-site networks.

This guide is specific to the Shared Design model, the key design considerations for when to choose this model follow.

CHOOSING A DESIGN MODEL

As discussed in the reference architecture guide, when choosing a design model, consider the following factors:

- **Scale**—What are the expected number of sessions and bandwidth required for the applications? Is this deployment for a proof-of-concept? Are the traffic profiles for inbound, outbound, east-west and on-premise communication balanced? The shared model does not differentiate between traffic flows, and resources consumed by one traffic profile may affect overall performance. The shared model provides linear scaling across all traffic profiles by adding additional firewalls to the load-balancer backend pools. To provide increased scale for a specific traffic profile, consider the scaled and dedicated models.
- **Complexity**—Is it more important to keep individual device configuration simple and permit easier troubleshooting, or is it acceptable to take on a somewhat higher administrative workload in order to reduce the total number of deployed devices? The shared model combines the configurations for all functions to a single set of devices with uni-directional and bi-directional flows across multiple zones. Careful consideration of any changes is necessary in order to evaluate overall impact, and configuration errors may be more likely. For simplified configuration and/or reduced impact of configuration errors, consider the scaled and dedicated models.
- **Resiliency and high availability**—Are there differentiated availability requirements for different traffic profiles? The shared model provides the same level of availability for all profiles. To provide differentiated availability for high priority traffic profiles, consider using the scaled and dedicated models.

Design Models

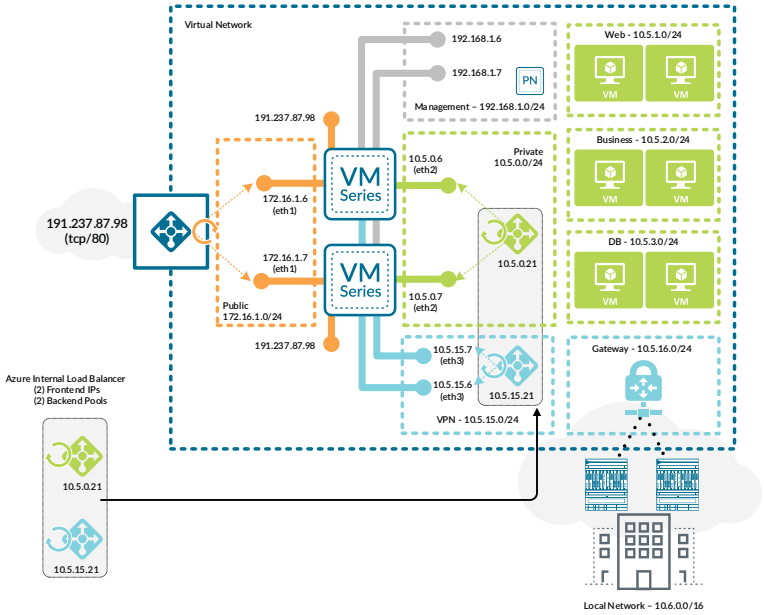
The design models primarily differ in how traffic flows are divided amongst VM-Series firewalls while offering you flexibility in the number of firewalls, scale, and operational resiliency. Consider which model best fits your needs and use it as a starting point for your design. The design models in this reference design are the:

- **Shared model**—In this model, all traffic flows through a single set of firewalls. This model keeps the number of firewalls low for small deployments and proof-of-concepts. However, the technical integration complexity is high. The deployment details for this design model only are covered in this guide.
- **Scaled model**—The model separates inbound traffic flows onto a dedicated set of firewalls while all other traffic flows through a shared firewall set. This design reduces technical integration complexity and increases scale compared to the shared model. The deployment details for this design model are covered in the Security Operating Platform on Azure Deployment Guide (Scaled Design Model).
- **Dedicated model**—Inbound, outbound and east-west, and backhaul traffic are each on dedicated sets of firewalls. This model offers increased operational resiliency and reduces the chances of high bandwidth use from one traffic profile affecting another. This design model does not currently have a deployment guide.

SHARED DESIGN MODEL

In the shared design model, a common set of firewalls provides visibility and control of all traffic profiles (inbound, outbound, east-west, backhaul). The firewalls are members of an availability set that distributed their virtual machines across the Azure infrastructure to avoid downtime caused by infrastructure maintenance or failure.

Figure 1 Shared design model

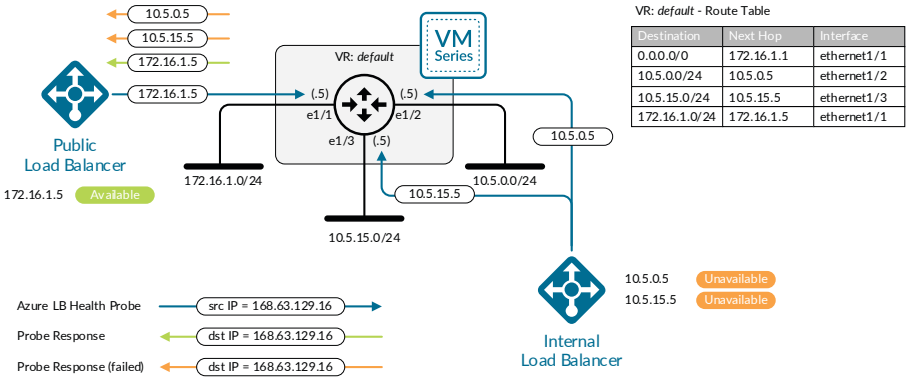


Inbound Traffic

For inbound traffic, a public load-balancer distributes traffic to the firewalls. To simplify firewall configuration, the front-end public IP address is associated with a DNS name and floating IP is enabled on the load-balancer rules. The public load-balancer's health probes monitor firewall availability through the HTTPS service activated in the interface management profile. Connectivity to the HTTPS service is limited to traffic sourced from the health probe IP address.

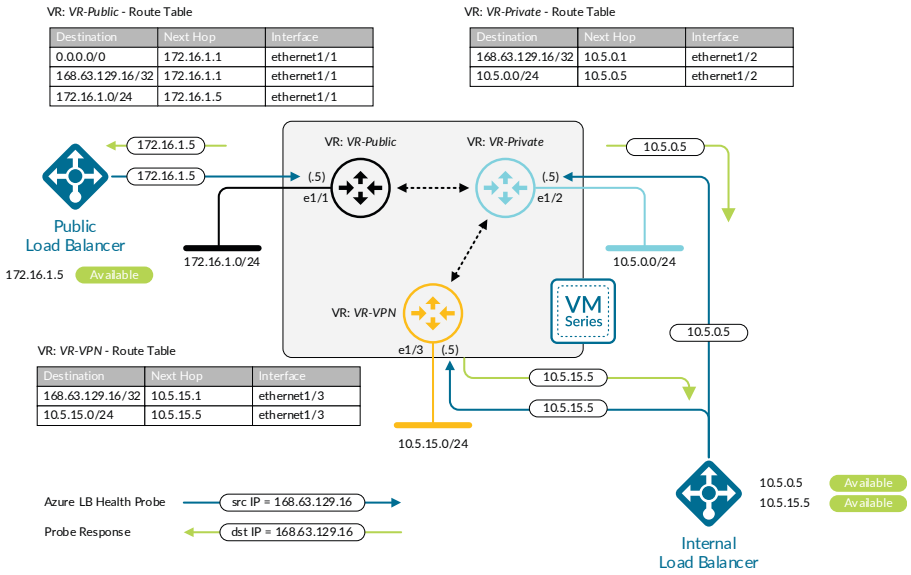
User-defined routes direct traffic from the subnet that contains the public interfaces to the other networks in the VNet to the next-hop of *none*. This ensures the public subnet can only communicate to private resources through the firewall.

Figure 2 Health probe failures with single virtual router



The public interface uses a dedicated virtual router. Static routes define a default route out the public interface as well as a route to private networks through the virtual router dedicated to the private interface. Dedicated virtual routers are required in the shared design model because Azure always sources load-balancer health probes from the same IP address. Dedicated virtual routers allow the firewall to have the interface that received the health probe to source responses.

Figure 3 Health probes with multiple virtual routers



The firewall applies both a destination and source NAT to inbound traffic. Destination NAT translates the FQDN address object associated with the load-balancer public DNS name to the virtual machine or load-balancer on the private network. The source NAT translates the source to be the IP address of the private interface of the firewall, ensuring return traffic flows symmetrically.

The firewall security policy allows appropriate application traffic to the resources in the private network while firewall security profiles prevent known malware and vulnerabilities from entering the network in traffic allowed in the security policy.

Outbound Traffic

For outbound traffic, an internal load-balancer distributes traffic to the firewalls. User-defined routes on the private subnets direct traffic to the load-balancer's frontend IP address, which shares a subnet with the firewall private interfaces. Load-balancer rules forward all TCP and UDP ports to the firewalls. Common ports required for outbound traffic include UDP/123 (NTP), TCP/80 (HTTP), and TCP/443 (HTTPS). DNS is not needed, because virtual machines communicate to Azure name services directly through the Azure network fabric. The internal load-balancer's health probes monitor firewall availability through the HTTPS service enabled in the interface management profile. Connectivity to the HTTPS service is limited to traffic sourced from the health probe IP address.

The private interface uses a dedicated virtual router. Static routes are defined for the health probe IP address and private network range out the private interface. Additionally, a static default route forwards traffic to the virtual router dedicated to the public interface.

The firewall applies source NAT to outbound traffic. When the outbound traffic originates from a resource that is associated with a public IP address, source NAT translates outbound traffic to the FQDN address object. For private resources not associated with a public IP address, the firewall translates the source address to its public interface. An Azure public IP address is associated with each firewall's public interface which is required when the interface is also associated with an inbound public load-balancer's backend pool.

Caution

Because bi-directional NAT matches traffic on any zone, do not enable bi-directional NAT in NAT policy rules. Otherwise, the NAT policy may incorrectly translate east-west traffic.

The firewall security policy allows appropriate application traffic from the resources in the private network to the internet. You should implement the security policy by using positive security policies (whitelisting). Security profiles prevent known malware and vulnerabilities from entering the network in return traffic allowed in the security policy. URL filtering, file blocking, and data filtering protect against data exfiltration.

East-West Traffic

East-west traffic, or traffic between private subnets, uses the same internal load-balancer to distribute traffic to the firewalls as the outbound traffic. User-defined routes to the private network subnets are applied to the private subnets and direct traffic to the load-balancer's frontend IP address. The existing load-balancer rules for outbound traffic apply to east-west traffic as well, and apply to all TCP and UDP ports.

The firewall should not translate the destination for traffic between private subnets. Like inbound traffic, source NAT is required for return traffic to flow symmetrically. A positive control security policy should allow only appropriate application traffic between private resources and requires that the default intrazone security policy rules be overridden and modified to deny traffic. Security profiles should also be enabled to prevent known malware and vulnerabilities from moving laterally in the private network through traffic allowed in the security policy.

Backhaul and Management Traffic

User-defined routes applied to the gateway subnet direct traffic that has a destination in the private network range to the internal load-balancer with an additional frontend IP dedicated to incoming traffic from the backhaul connection. The load-balancer then distributes traffic to a new backend pool with dedicated interfaces on the firewalls. Dedicated firewall interfaces are used for the backhaul traffic because they allow for enhanced security policies that can take zone into account.

On the firewall, a dedicated virtual router for the backhaul interface and static routes provides reachability to the on-site networks and health probe IP address. Static routes on both the backhaul and private virtual routers provide bi-directional traffic flow between the on-site and private network ranges. Traffic originating in private subnets and destined to on-site networks follows the same path as east-west traffic. All that is required is the addition of user-defined routes that forward on-site network ranges to the outbound/east-west load-balancer frontend.

Traffic from the on-site networks communicates to the management subnet directly. This allows on-site administrators to manage the firewalls even when a misconfiguration occurs in user-defined routing or load-balancers.

User-defined routes blackhole the traffic to the on-site networks from public subnets by sending the traffic to a next-hop of *none*.

Assumptions and Prerequisites

Microsoft Azure:

- Your organization has a valid active subscription associated with your Azure user account.
- Two resources groups are used—one for Panorama and common resources and a separate resource group for dataplane devices
- Uses Standard-SKU IP addresses and load-balancers, except where specifically noted in the guide.
- Only IPv4 networking is used.
- Web servers are already deployed with their own dedicated load-balancer.
- Business and DB servers are already deployed.

Palo Alto Networks next-generation firewalls and Panorama:

- Device configuration is centrally managed with Panorama using templates and device groups.
- Panorama will be deployed on Azure in management-only mode.
- Firewall logging uses the Palo Alto Networks cloud-based Logging Service.
- The PAN-OS version tested in this deployment guide is 8.1.2 for all devices.
- The Cloud services plugin for Panorama is 1.1.0.
- The on-premise firewalls for backhaul traffic are already deployed with a set of interfaces connected to the public and private zones and integrated into the on-premise dynamic routing protocol.

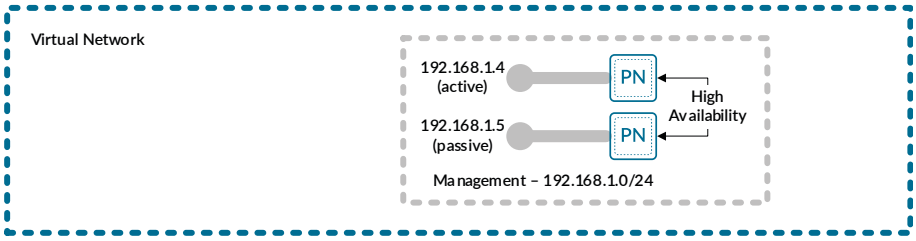
Palo Alto Networks licensing:

- Your organization has a Panorama license for the current and expected number of managed VM-Series firewalls.
- Sufficient VM-Series licensing for the current and expected number of VM-Series firewalls. This guide assumes you are using the BYOL licensing option.
- Requires a bundled auth-key for VM-Series if you intend to use bootstrapping.
- Logging Service instance is provisioned with sufficient storage to support the required data retention period and auth-code has been issued.
- Logging Service region used is americas.

Deployment Details for Panorama

Panorama is deployed in a new dedicated Azure Resource Group which includes the VNet used for the Shared Design Model. You must complete two complementary procedure groups in order to deploy Panorama. The first procedure group configures the Azure environment. Once Azure is configured, then Panorama may be deployed.

Figure 4 Panorama high-availability mode deployed on Azure



Several of the resources created on Azure are used by procedures later in this guide When the resource already exists, you will be instructed to modify an existing resource rather than create a new resource.

Procedures

Creating and Configuring Azure Common Resources

1.1 Create the Resource Group

1.2 Create the Virtual Network

1.3 Create the Public IP Address for Panorama

1.4 Create and Apply the Network Security Group

1.5 Create the Availability Set

1.6 Create the Storage Account

1.7 Verify Resource Creation Completed

The following procedures are completed using the Azure Resource Manager. Sign in to Azure at https://portal.azure.com.

> **Note**
>
> Some Azure templates provide an option to create a new resource when needed at deployment time and other templates require resources to be created in advance. Where possible, this guide creates the resource in advance and then references the existing resource at deployment time.

This procedure group creates the resources listed in the following table as preparation for deploying Panorama.

Table 1 Azure resources required for deployment

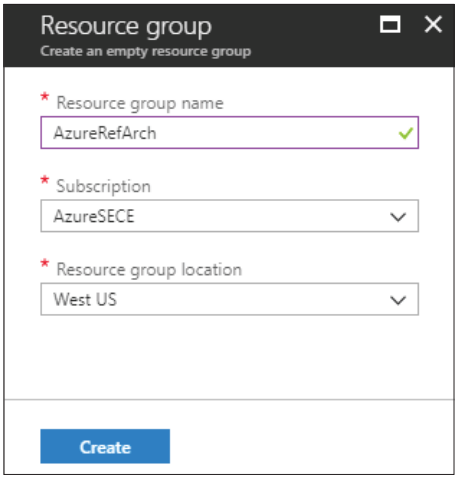
Parameter	Value	Comments
Resource group	AzureRefArch	—
Subscription	<value>	Must have a valid Azure subscription
Resource group location	<location>	Tested in West US
Virtual network	AzureRefArch-VNET	—
Public IP for Panorama management (primary)	Azure-Panorama-1	Panorama, or primary Panorama when using Panorama High Availability
Public IP for Panorama management (secondary)	Azure-Panorama-2	Optional—secondary Panorama when using Panorama High Availability
Availability set	AzureRefArch-AS	Suggested if planning for Panorama High Availability
Diagnostics storage account	azurerefarchv2diag	—

1.1 Create the Resource Group

All resources deployed in this guide should use the same location. The deployment in this guide was tested in **West US**.

Step 1: In **Home** > **Resource groups**, click **Add**.

Step 2: In the **Resource group name** box, enter **AzureRefArch** and select the desired values for the **Resource group location**. Click **Create**.



1.2 Create the Virtual Network

The virtual network (VNet) is created with an initial IP address space and a subnet that must be within the IP address space. The VNet can be modified after creation to add additional IP address space and subnets. Only the first entry in the following table is configured in this procedure.

Table 2 Virtual network IP addressing and subnets

Address space	Subnet	Address range	Comments
192.168.1.0/24	Management	192.168.1.0/24	Initial address space, subnet, and range
172.16.0.0/23	Shared-Public	172.16.1.0/24	Configured in a separate procedure
10.5.0.0/16	Shared-Private Shared-Web Shared-Business Shared-DB Shared-VPN	10.5.0.0/24 10.5.1.0/24 10.5.2.0/24 10.5.3.0/24 10.5.15.0/24	Configured in separate procedures

Step 1: In **Home > Virtual networks**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-VNET**.

Step 3: In the **Address space** box, enter **192.168.1.0/24**.

Note

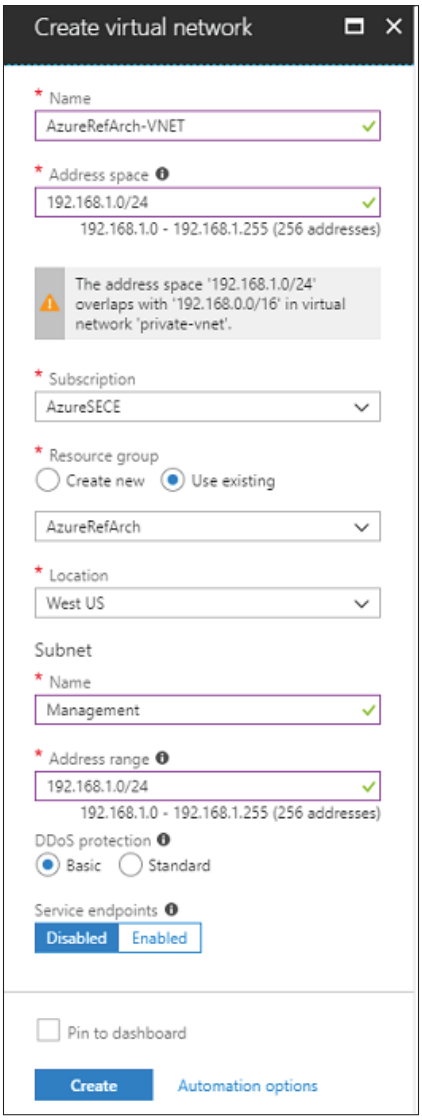
Azure Resource Manager provides a warning if the proposed address space overlaps with address space already assigned in another VNet within the same subscription. These warnings can be ignored if communication between these VNets is not required. Otherwise, choose a different non-overlapping address space.

Step 4: In the Resource Group section, choose **Use Existing** and then select **AzureRefArch**.

Step 5: In the Subnet section **Name** box, enter **Management**.

Step 6: In the Subnet section **Address Range** box, enter **192.168.1.0/24**.

Step 7: Click **Create**.



1.3 Create the Public IP Address for Panorama

The Panorama virtual machines deployed on Azure are managed using public IP addresses unless on-site network connectivity has been established. The process to configure on-site network connectivity is included later in this guide.

This procedure creates a public IP address that is associated with the management interface of the primary Panorama system at deployment time. If necessary, this procedure is repeated to create an additional public IP address for the secondary Panorama system. The parameters listed in Table 1 are used to complete this procedure.

Note

This guide uses Standard-SKU IP addresses in all procedures except where specifically noted.

Take note of the fully qualified domain name (FQDN) that is defined by adding the location specific suffix to your DNS name label. We recommend managing your devices by using the DNS name rather than the public IP address, which may change.

Step 1: In **Home > Public IP addresses**, click **Add.**

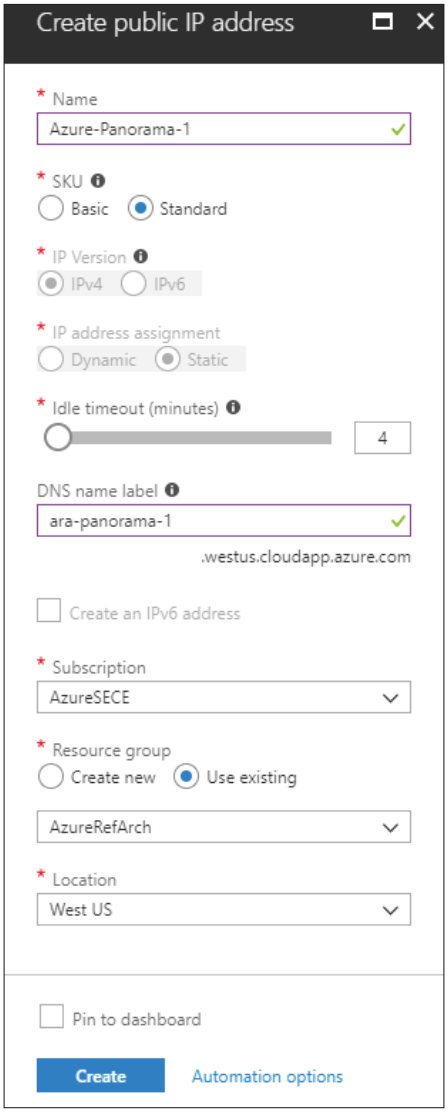
Step 2: In the **Name** box, enter **Azure-Panorama-1**.

Step 3: Select **Standard** SKU.

Step 4: In the **DNS name label** box, enter **ara-panorama-1**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 6: Click **Create**.



1.4 Create and Apply the Network Security Group

Azure requires that a network security group (NSG) must be applied on a subnet or NIC of your virtual machine resource or traffic is not permitted to reach the resource when Standard SKU public IP addresses are associated with the resource.

> **Note**
>
> This guide uses Standard-SKU IP addresses in all procedures except where specifically noted.

This procedure creates NSGs for use with the management subnet. Each NSG includes default rules that allow for traffic within the VNET and from the Azure Load Balancer health probes.

Step 1: In **Home > Network Security groups**, click **Add.**

Step 2: In the **Name** box, enter **AllowManagement-Subnet**.

Step 3: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 4: In **Home > Network security groups > AllowManagement-Subnet**, in the SETTINGS section, click **Inbound security rules**.

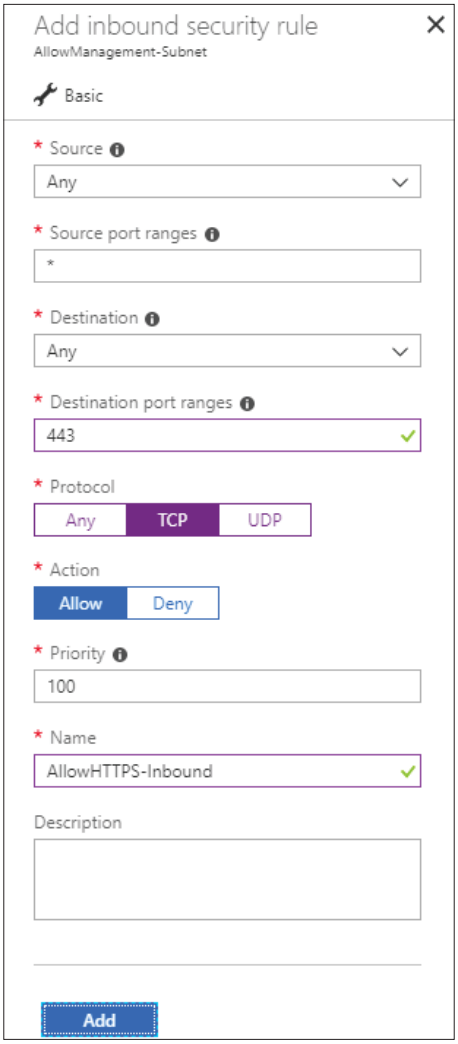
Step 5: Click **Add**. The Add inbound security rule pane appears.

Step 6: In the **Destination port ranges** box, enter **443**.

Step 7: In the **Protocol** section, select **TCP**.

Step 8: In the **Name** box, enter **AllowHTTPS-Inbound**.

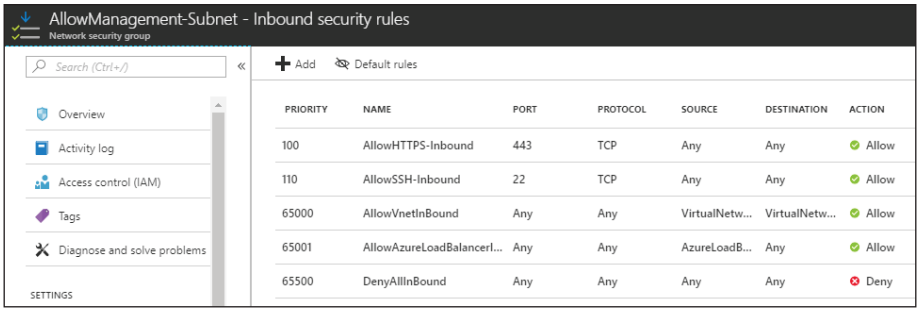
Step 9: Click **Add**.



Step 10: Repeat Step 4 through Step 9 with the following values:

- Destination port ranges—**22**
- Priority—**110**
- Name—**AllowSSH-Inbound**

> **Note**
>
> Azure presents warning messages when the NSG rules expose various ports to the Internet. We advise using more restrictive rules outside of a testing environment.

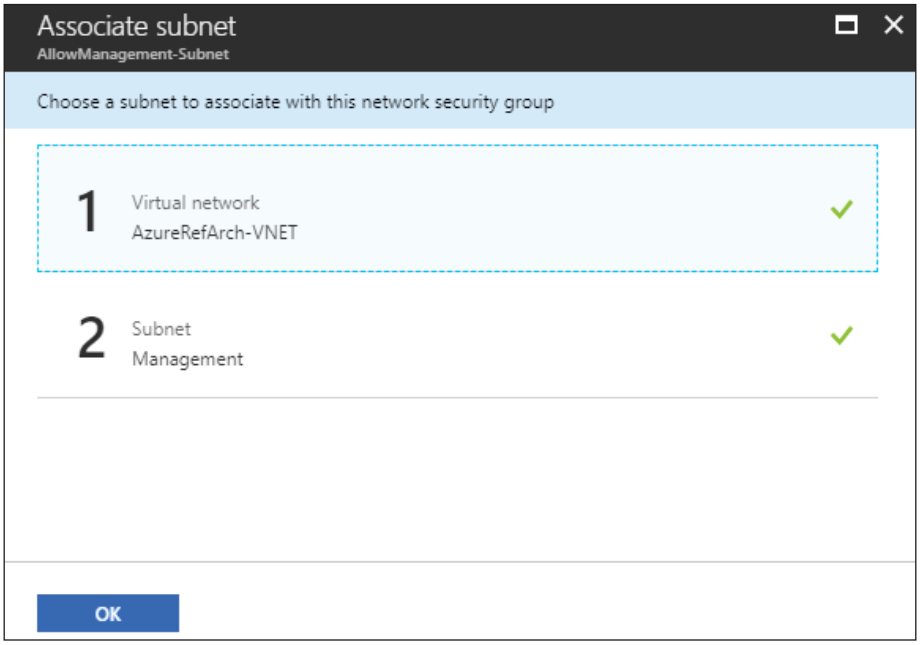


Step 11: In **Home > Network security groups > AllowManagement-Subnet**, in the SETTINGS section, click **Subnets**.

Step 12: In the **AllowAll-Subnet — Subnets** pane, click **Associate**.

Step 13: Click on the **Virtual network — Choose a virtual network** section. From the **Choose virtual network** list, select **AzureRefArch-VNET**.

Step 14: Click on the **Subnet — Choose a subnet** section. From the **Choose subnet** list, select **Management**, and then click **OK**.



1.5 Create the Availability Set

The Panorama high-availability model benefits from the use of an availability set with two fault domains. This ensures that the primary and secondary Panorama systems are deployed on different fault domains.

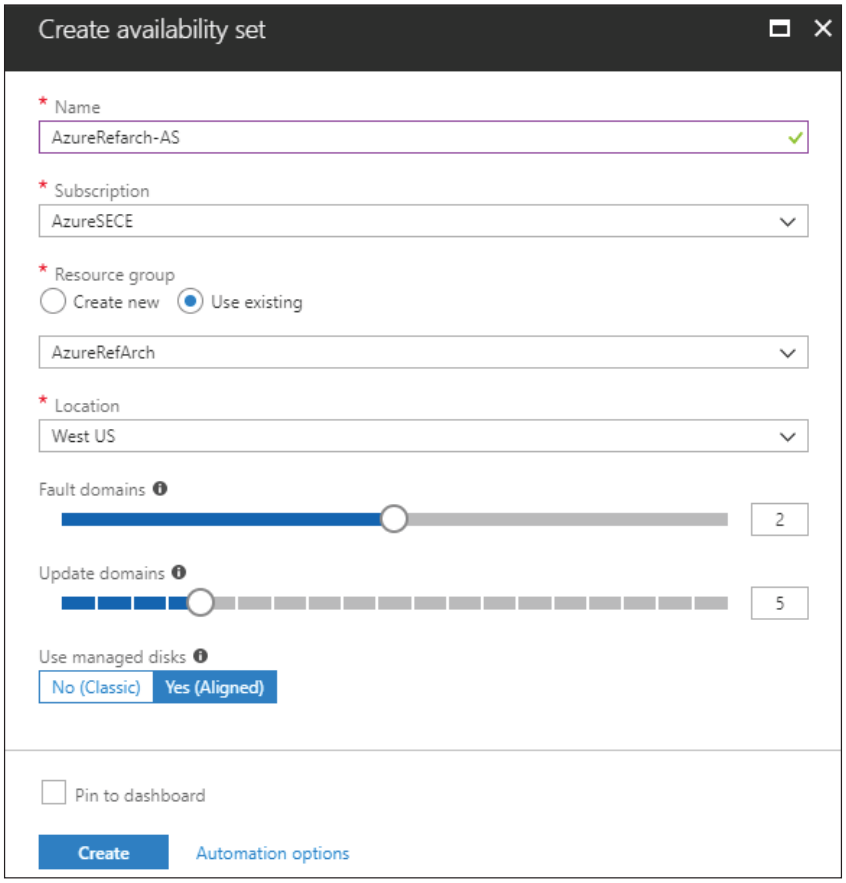
> **Note**
>
> You can only configure an availability set on a virtual machine during its initial deployment. You can't modify a virtual machine's availability-set configuration after the virtual machine is deployed.

Step 1: In **Home > Availability sets**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-AS**.

Step 3: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 4: Click **Create**.



1.6 Create the Storage Account

Panorama and other resources require general purpose storage for diagnostics and bootstrapping.

Step 1: In **Home > Storage accounts**, click **Add.**

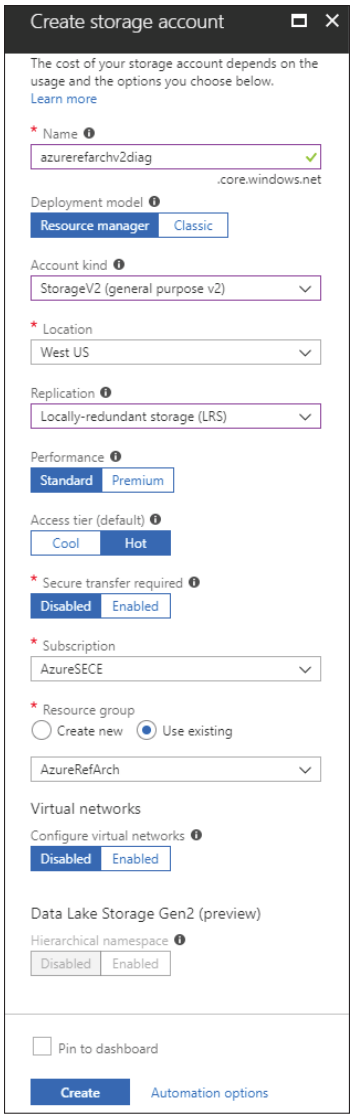
Step 2: In the **Name** box, enter **azurerefarchv2diag**.

Step 3: In the **Account kind** list, select **StorageV2 (general purpose v2)**.

Step 4: In the **Replication** list, select **Locally-redundant storage (LRS)**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

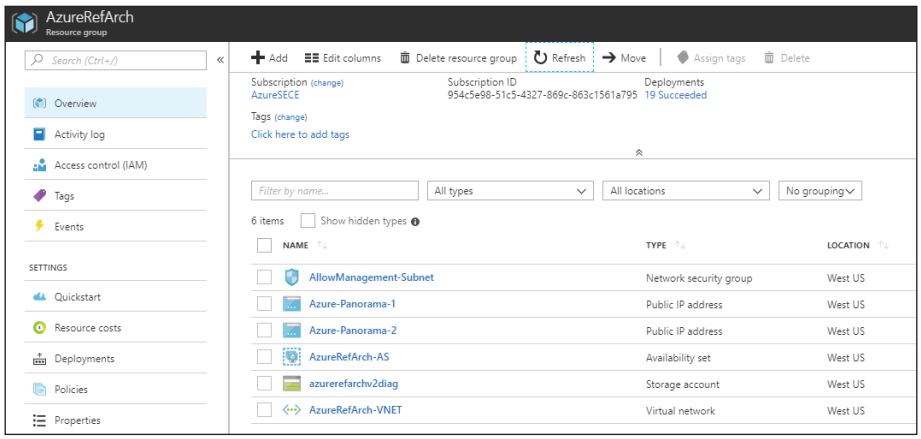
Step 6: Click **Create**.



1.7 Verify Resource Creation Completed

Some Azure deployments are time consuming, and if any resources are missing, the deployment fails. It is quicker to verify that all of the necessary resources exist before proceeding with a deployment than waiting until a deployment fails.

Step 1: In **Home > Resource Groups**, select **AzureRefArch**.



Step 2: Verify that the resource group, NSGs, public IP addresses, availability set, storage account, and VNet have been successfully created.

Procedures

Deploying Panorama on Azure

2.1 Create Panorama Virtual Machine

2.2 Change Azure Assigned IP Address from Dynamic to Static

2.3 License Panorama on Azure

2.4 Update Panorama Software to Recommended Version

2.5 Configure Panorama High Availability (optional)

2.6 Activate Logging Service

2.7 Install Cloud Service Plugin Version 1.1.0

The following procedures use the Azure Resource Manager and the Panorama device portal. Sign in to Azure at https://portal.azure.com. Details on how to access Panorama after deployment are included in the relevant procedures.

This procedure deploys Panorama in management mode. Panorama defaults to management mode when it detects that there is not sufficient log storage capacity to run in Panorama mode.

Table 3 Panorama deployment parameters

Parameter	Value	Comments
Name	Azure-Panorama-1 Azure-Panorama-2	Primary system Secondary system (optional for high availability)
VM disk type	Standard HDD	Required for D3_v2 Standard.
Username	refarchadmin	May not use “admin”
Authentication type	<password>	Complex password required
Subscription	<value>	Must have a valid Azure subscription
Resource group name	Use existing AzureRefArch	—
Location	<location>	Tested in West US
Panorama VM size	D3_v2 Standard	Setup Prerequisites for the Panorama Virtual Appliance
Availability set	AzureRefArch-AS	Recommend to use Availability Set if planning for active/standby Panorama. Cannot change setting after deployment.
Storage Use managed disks	Yes	—
Virtual Network	AzureRefArch-VNET	—
Subnet	Management	—
Public IP	Azure-Panorama-1 Azure-Panorama-2	DNS configured as: ara-panorama-1 DNS configured as: ara-panorama-2
Network security group	None	NSG is applied at subnet level
Auto-shutdown	No	—
Monitoring boot diagnostics	On	—
Diagnostics storage account	azurerefarchv2diag	—

2.1 Create Panorama Virtual Machine

Use the parameters in Table 3 to deploy Panorama.

Step 1: In **Home > Virtual machines**, click **Add.**

Step 2: In the **Search compute** box, enter **Panorama**, and then and press Enter to search.

Step 3: In the search results, click **Panorama (BYOL)**.

Step 4: In **Home > Virtual machines > Compute > Panorama (BYOL)**, click **Create**.

Step 5: In the **Name** box, enter **Azure-Panorama-1**.

Step 6: In the **VM disk type** list, select **Standard HDD**.

Step 7: In the **Username** box, enter **refarchadmin**.

Step 8: For **Authentication type**, select **Password**.

Step 9: In the **Password** and **Confirm Password** boxes, enter the password.

Step 10: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch** and click **OK**.

Step 11: From the **Available** sizes, select **D3_v2 Standard**, and then click **Select**.

Step 12: Click the **Availability set** section to modify the default setting. From the **Change availability set** list, select **AzureRefArch-AS**.

Step 13: Click the **Virtual network** section to modify the default setting. From the **Choose virtual network** list, select **AzureRefArch-VNET**.

Step 14: Click the **Subnet** section to modify the default setting. From the **Choose subnet** list, select **Management**.

Step 15: Click the **Public IP address** section to modify the default setting. From the **Choose public IP address** list, select **Azure-Panorama-1**. Dismiss the dialog box warning for "Your unsaved edits will be discarded." by clicking **OK**.

Step 16: Click the **Network security group (firewall)** section to modify the default setting. From the **Choose network security group** list, select **None**. The subnet already has an associated NSG.

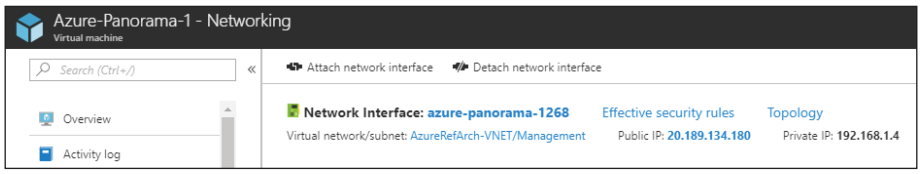
Step 17: Click the **Diagnostics storage account** section to modify the default setting. From the **Choose storage account** list, select **azurerefarchv2diag**, and then click **OK**.

Step 18: After validation passes, review the **Offer details**, **Summary**, and **Terms of use** sections. If the information is correct and acceptable, then click **Create**.

2.2 Change Azure Assigned IP Address from Dynamic to Static

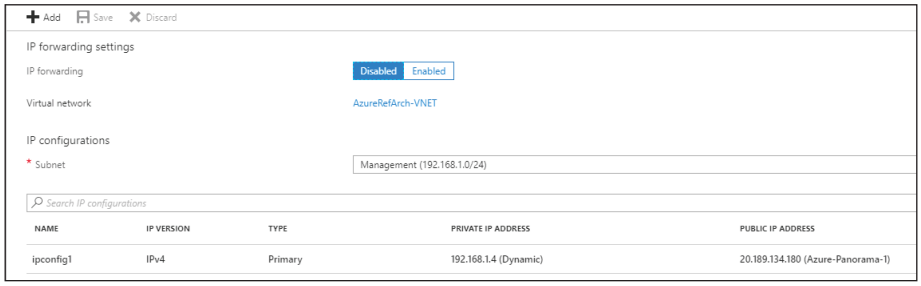
You must configure Panorama with a static IP address. Azure networking provides the IP address to Panorama using DHCP but by default is configured to use dynamic assignment. If the current IP address is acceptable, convert the address assignment to static. To change the IP address, convert the assignment to static and then assign an available address. Any IP address changes require a restart of the Panorama virtual machine.

Step 1: In **Home > Virtual machines > Azure-Panorama-1**, click **Networking**.

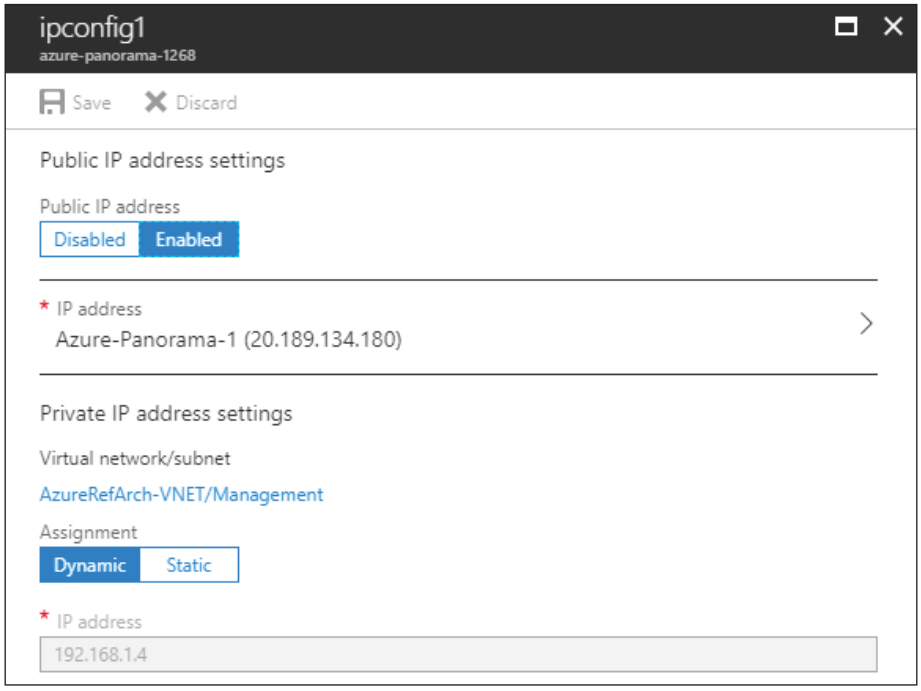


Step 2: Click the **Network interface** name (example: **azure-panorama-1268**).

Step 3: Click **IP configurations**.



Step 4: Click the IP configuration row to edit the settings.



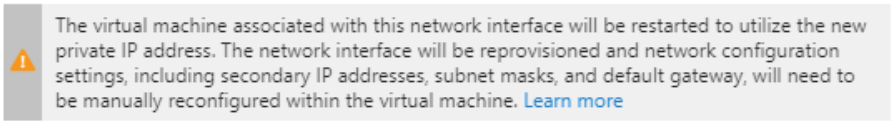
Step 5: In the Private IP address settings section, click **Static** to convert from dynamic to static configuration.

Step 6: (Optional—change the static IP address to preferred value.) In the **IP address** box, enter a new IP address. The chosen IP address must be unassigned in Azure.

Caution

Changing an IP address forces a restart of the virtual machine.

Step 7: Click **Save**. The virtual machine restarts if the IP address is changed.



2.3 License Panorama on Azure

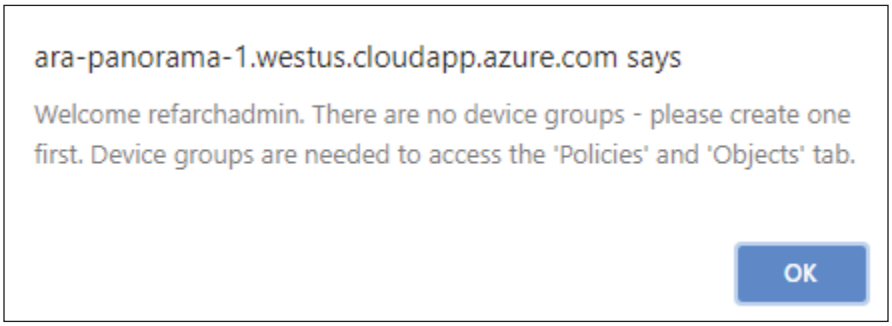
Panorama is now running on Azure but is unlicensed and using a factory default configuration. Based on the size selected for the Panorama virtual machine, the **System Mode** is management-only.

This procedure assumes that you have a valid serial number for your Panorama device(s) and that registration on the customer support portal (https://support.palotaltonetworks.com) is complete.

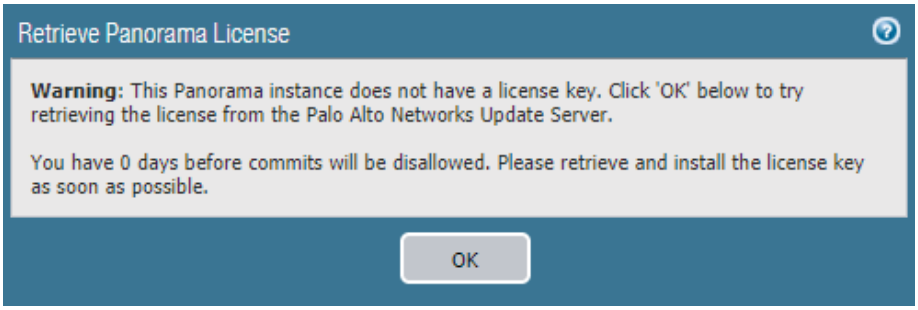
Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com)

You will see a series of dialog boxes and warnings.

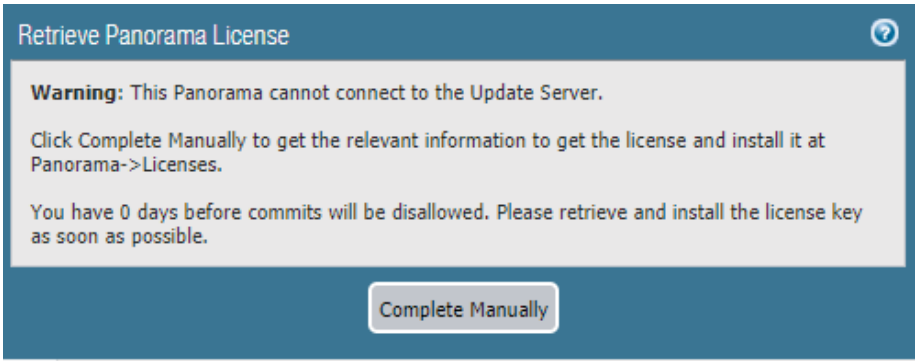
Step 2: Click **OK** to accept the **There are no device groups** dialog box.



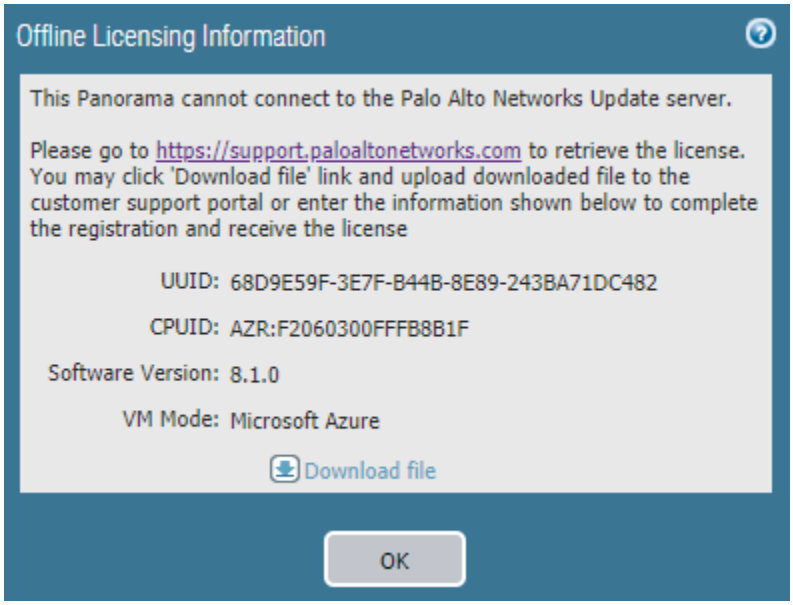
Step 3: Click **OK** to accept the **Retrieve Panorama License** warning dialog box.



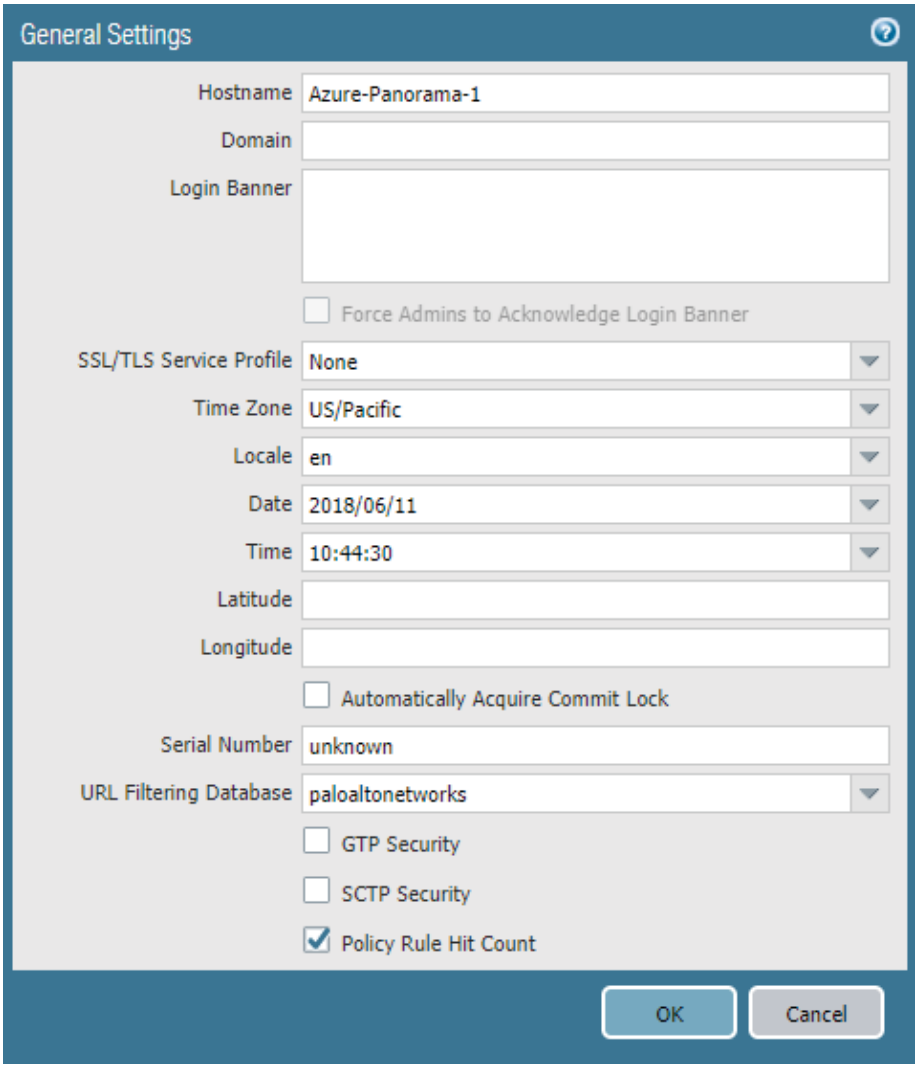
Step 4: Click **Complete Manually** to accept the next **Retrieve Panorama License** warning dialog box.



Step 5: Click **OK** to accept the **Offline Licensing Information** dialog box.



Step 6: In **Panorama > Setup > Management > General Settings**, click the Edit cog.



Step 7: In the **Domain** box, enter the domain suffix.

Step 8: In the **Time Zone** list, select the appropriate time zone (example: **US/Pacific**).

Step 9: In the **Serial Number** box, enter the serial number from the customer support portal, and then click **OK**.

Step 10: In **Panorama > Setup > Services**, click the Edit cog.

Step 11: In the **Primary DNS Server** box, enter **168.63.129.16.**

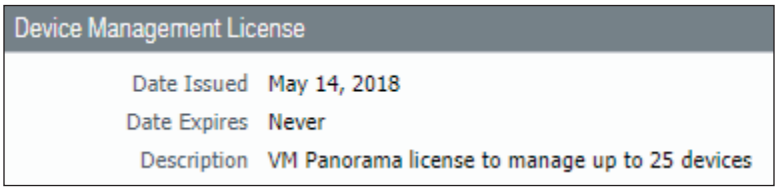
Step 12: Change to the NTP tab. In the Primary NTP Server section **NTP Server Address** box, enter **0.pool.ntp.org**.

Step 13: In the Secondary NTP Server section **NTP Server Address** box, enter **1.pool.ntp.org**, **and then** click **OK**.

Step 14: On the **Commit** menu, click **Commit to Panorama**.

Step 15: In **Panorama > Licenses**, click **Retrieve license keys from license server**.

Step 16: Verify **Device Management License** is active.



2.4 Update Panorama Software to Recommended Version

Step 1: Navigate to **Panorama > Software**.

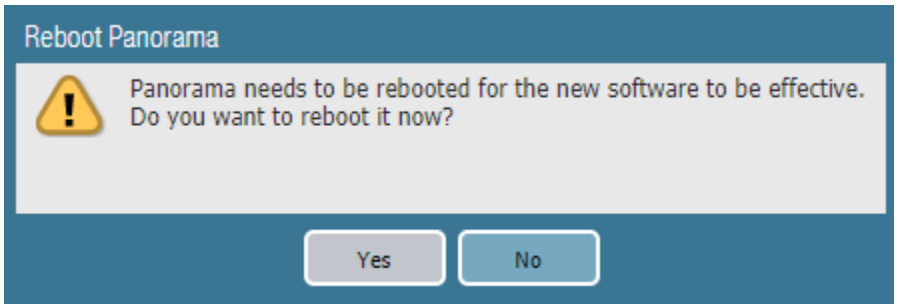
> **Note**
>
> If you receive an **Operation Failed** warning with the message **No update information available**, you may click **Close** to acknowledge. No action is required.

Step 2: In **Panorama > Software**, click **Check Now**.

Step 3: For version **8.1.2**, in the **Actions** column, click **Download**. Click **Close** when complete.

Step 4: After the status in the **Available** column has changed to **Downloaded**, and then in the **Action** column, click **Install**.

Step 5: When prompted to Reboot Panorama, click **Yes**.



2.5 Configure Panorama High Availability (optional)

This procedure is necessary only to deploy Panorama in a high availability configuration. Panorama supports an HA configuration in which one peer is the active-primary and the other is the passive-secondary. If a failure occurs on the primary peer, it automatically fails over and the secondary peer becomes active.

The Panorama HA peers synchronize the running configuration each time you commit changes on the active Panorama peer. The candidate configuration is synchronized between the peers each time you save the configuration on the active peer or just before a failover occurs.

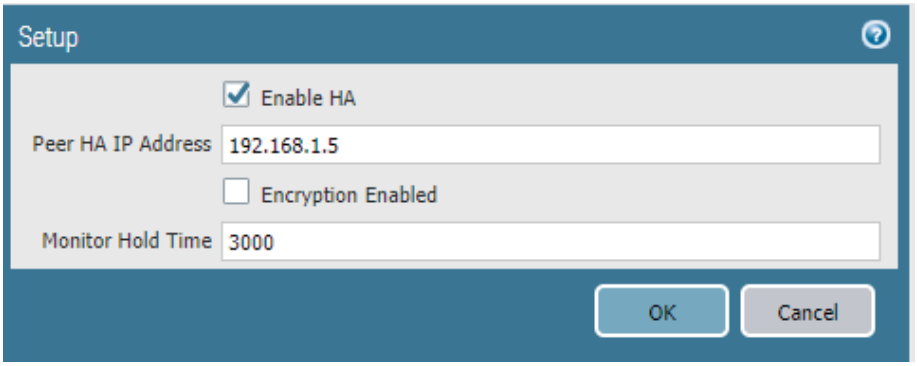
Settings that are common across the pair, such as shared objects and policy rules, device group objects and rules, template configuration, and administrative access configuration, are synchronized between the Panorama HA peers.

Perform Step 1 through Step 6 on the primary Panorama.

Step 1: In **Panorama > High Availability > Setup**, click the Edit cog.

Step 2: Select **Enable HA**.

Step 3: In the **Peer HA IP Address** box, enter **192.168.1.5**, and then click OK.



Step 4: In **Panorama > High Availability > Election Settings**, click the Edit cog.

Step 5: In the Priority list, select **primary**, and then click **OK**.

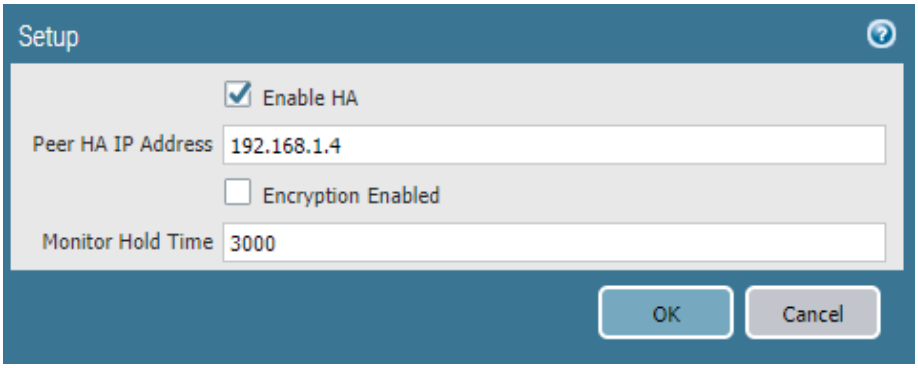
Step 6: On the **Commit** menu, click **Commit to Panorama**.

Perform Step 7 through Step 12 on the secondary Panorama.

Step 7: In **Panorama > High Availability>Setup**, click the Edit cog.

Step 8: Select **Enable HA**.

Step 9: In the **Peer HA IP Address** box, enter **192.168.1.4**, and then click OK.

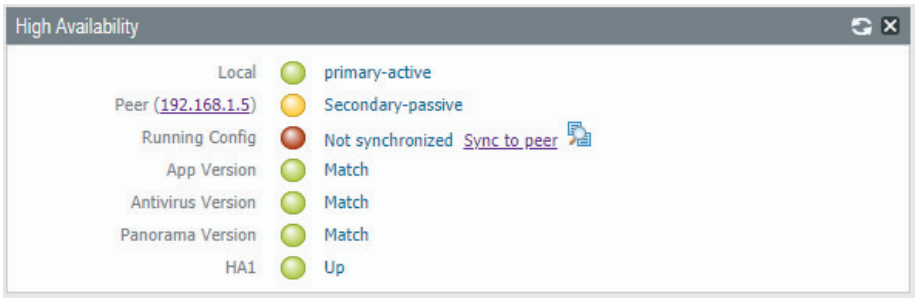


Step 10: In **Panorama > High Availability > Election Settings**, click the Edit cog.

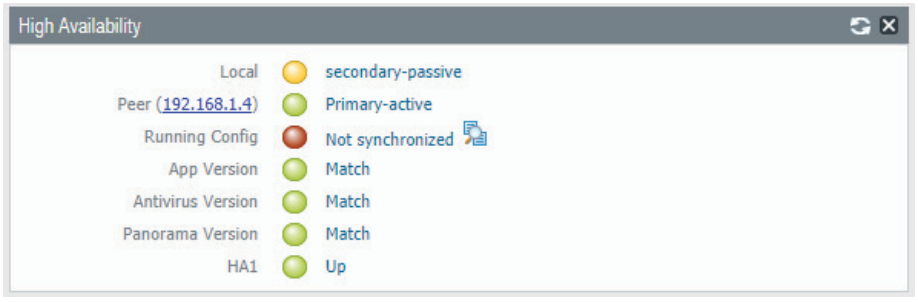
Step 11: In the **Priority** list, select **secondary**, and then click **OK**.

Step 12: On the **Commit** menu, click **Commit to Panorama**.

Step 13: On the primary Panorama, in **Dashboard > Widgets > System**, click **High Availability** to enable the **High Availability** dashboard widget. This adds a dashboard pane that displays the status of the Panorama peers.

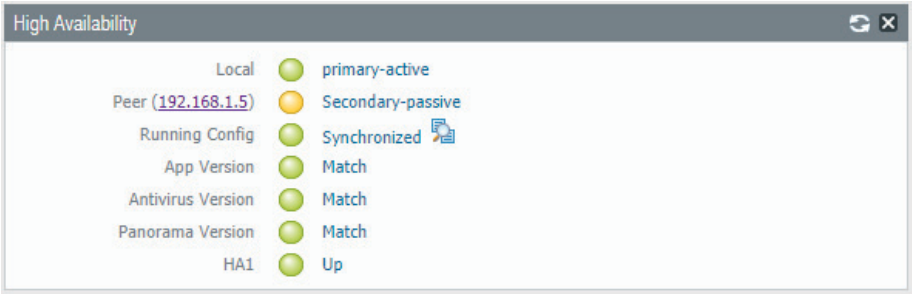


Step 14: Repeat Step 13 on the secondary Panorama.



Step 15: On the primary Panorama, in **Dashboard > High Availability**, click **Sync to peer**.

Step 16: Click **Yes** to accept the **Overwrite Peer Configuration** warning and proceed with the synchronization.



2.6 Activate Logging Service

The Logging Service requires an authorization code, which is used to activate the service. This procedure also assumes that you have a valid serial number for your Panorama device(s) and that registration on the customer support portal is complete.

The Logging Service instance is associated with the serial number of the primary Panorama. This procedure is not repeated for the secondary Panorama.

Step 1: Log in to the Customer Support Portal at https://support.paloaltonetworks.com.

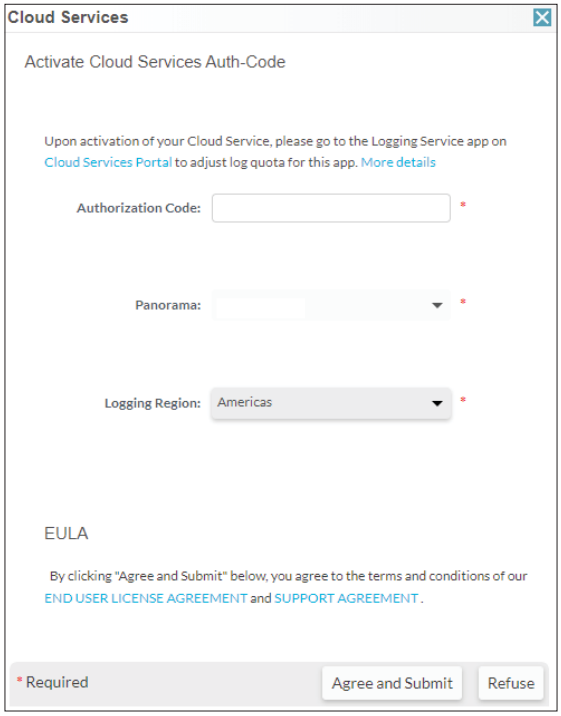
Step 2: Select **Assets > Cloud Services**.

Step 3: Click **Activate Cloud Services Auth-Code**.

Step 4: In the Cloud Services window, in the **Authorization Code** box, enter the authorization code (example: **I7654321**), and then press Tab key to advance. The **Panorama** and **Logging Region** boxes appear.

Step 5: In the Cloud Services window, in the **Panorama** list, select the value that corresponds to the serial number assigned to your primary Panorama.

Step 6: In the Cloud Services window, in the **Logging Region** list, select the value that corresponds to your region (example: **Americas**).



Step 7: Accept the EULA by clicking on **Agree and Submit**.

2.7 Install Cloud Service Plugin Version 1.1.0

If running Panorama in high availability mode, perform this procedure on the primary Panorama first. Then repeat this procedure for the secondary Panorama.

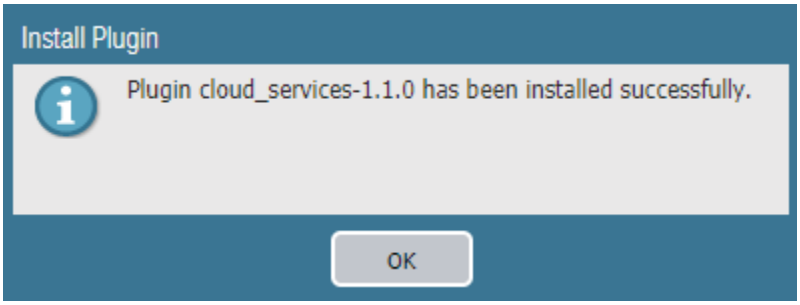
Step 1: In **Panorama > Plugins**, click **Check Now**.

Step 2: For **cloud _services-1.1.0**, in the **Actions** column, click **Download**.

Step 3: After the download is completed, click **Close**.

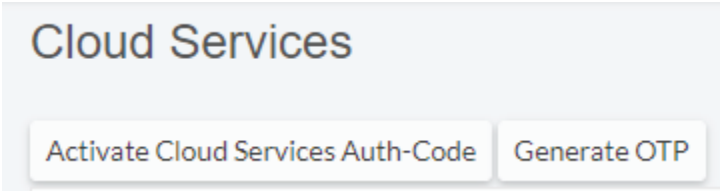
Step 4: After the status in the **Available** column changes to a check, and then in the **Action** column, click **Install**.

Step 5: Click **OK** to close the dialog box that indicates a successful installation.

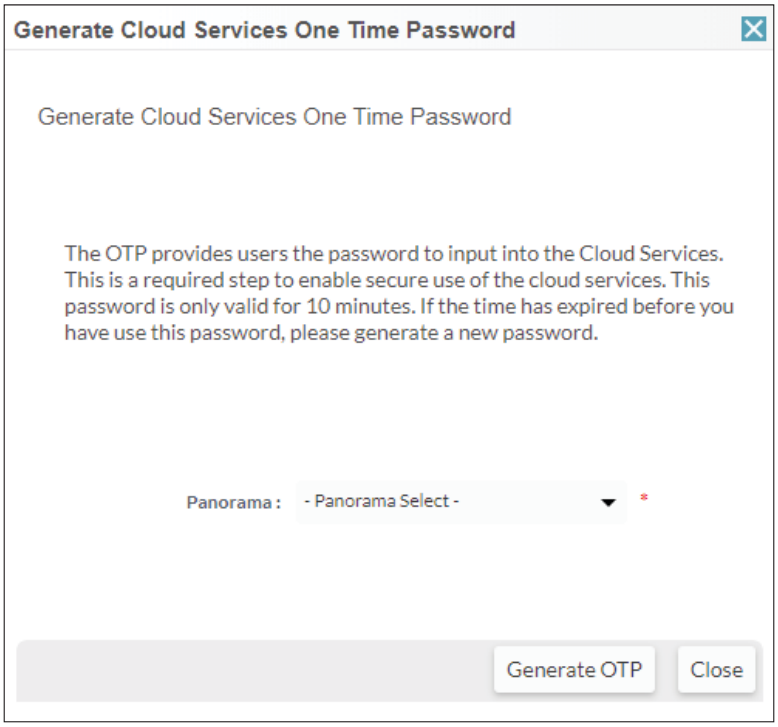


Perform Step 6 through Step 8 on the customer support portal (https://support.paloaltonetworks.com) to complete the association of Panorama to the cloud service.

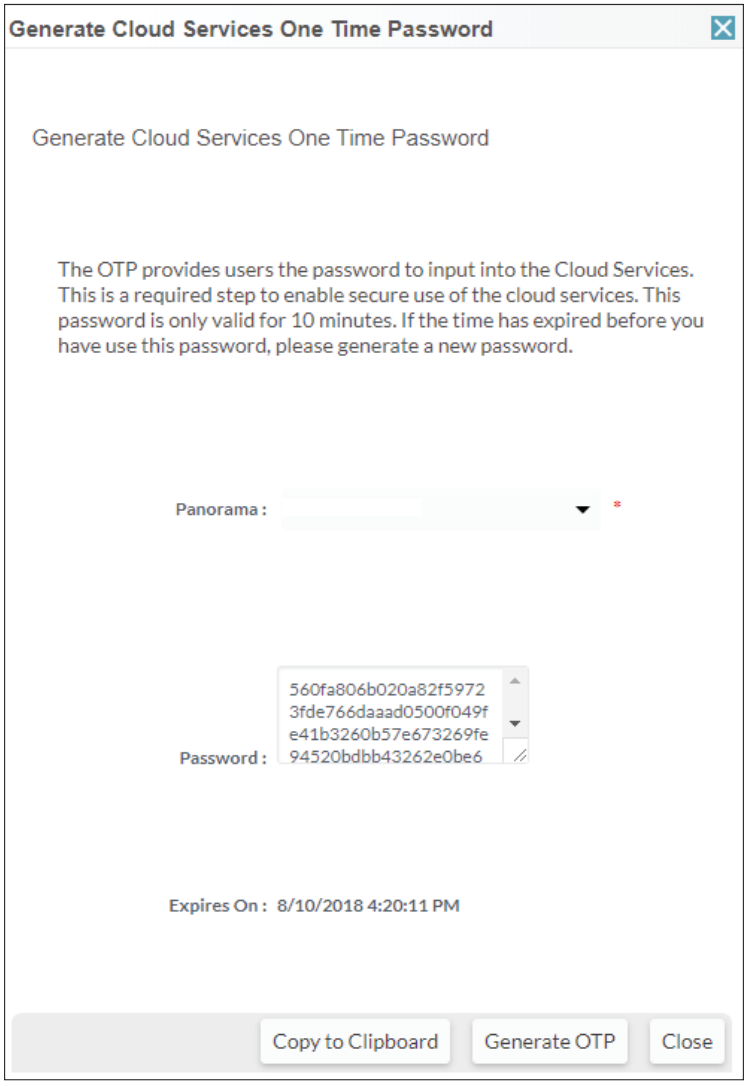
Step 6: In **Assets > Cloud Services**, click **Generate OTP**.



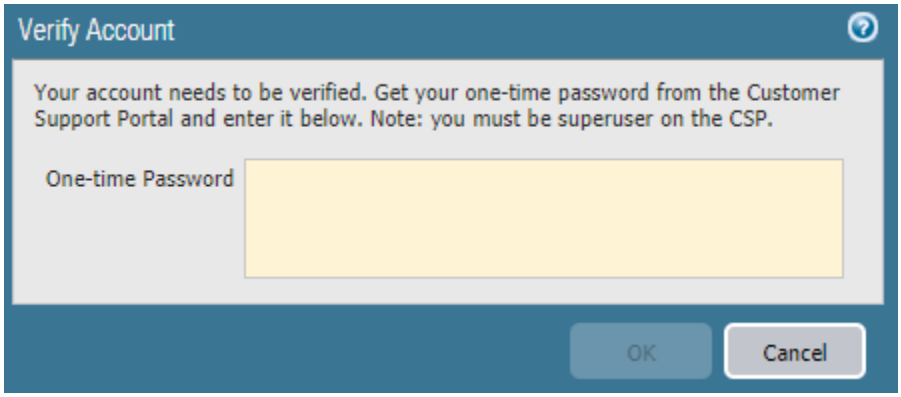
Step 7: In the Generate Cloud Services One Time Password window, in the **Panorama** list, select the serial number for the primary Panorama, and then click **Generate OTP**.



Step 8: In the Generate Cloud Services One Time Password window, click **Copy to Clipboard**.

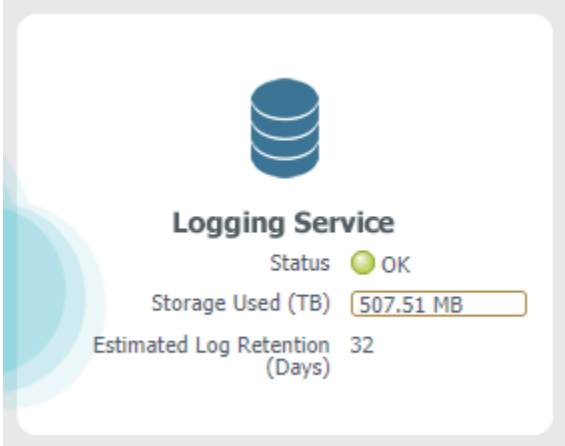


Step 9: On Panorama, navigate to **Panorama > Cloud Services > Status**, and then click **Verify**.



Step 10: In the **One-Time Password** box, paste the OTP that was generated from the Customer Support Portal.

Step 11: In **Panorama > Cloud Service > Status**, verify the status.



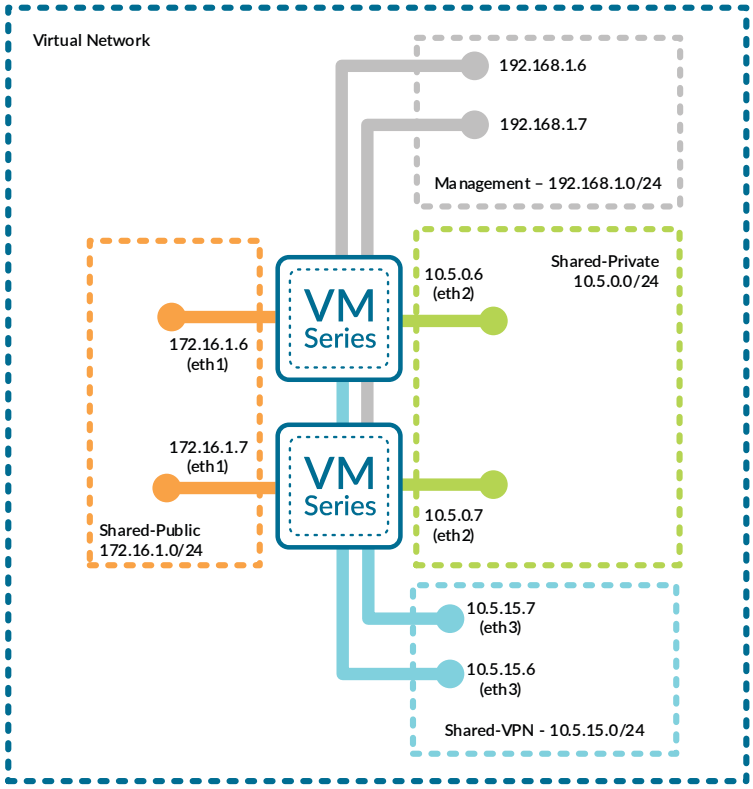
Step 12: If necessary, repeat this procedure for the secondary Panorama.

Deployment Details for VM-Series

The VM-Series firewalls are deployed in a new dedicated Azure Resource Group for the shared design model. Some Azure resources, such as the VNet, have already been allocated within the Azure Resource Group used for Panorama. You must complete multiple complementary procedure groups in order to deploy and configure the VM-Series.

The first procedure group modifies and configures the Azure environment. After Azure is configured, the second procedure group deploys the VM-Series and minimally configures each device to prepare for central management through Panorama.

Figure 5 Shared model—VM-Series deployment parameters



The third procedure group configures the Panorama configuration templates used by the each of VM-Series devices. All template based configuration is common across all VM-Series devices and only takes effect once pushed from Panorama to the VM-Series. After the templates are complete, the fourth procedure group registers the individual VM-Series devices with Panorama, associates them with the templates and placeholder device groups, pushes the configurations, and refreshes the licenses.

Procedures

Creating and Configuring Azure Common Resource for VM-Series

Azure has removed the option to select an existing resource group for marketplace solutions that enable multiple NICs. To deploy the firewall into an existing resource group, use the ARM template in the GitHub Repository or your own custom ARM template.

This procedure group creates the resources listed in the following table as preparation for deploying the VM-Series firewalls.

Table 4 Azure resources required for deployment

Parameter	Value	Comments
Virtual network	AzureRefArch-VNET	Existing VNet in the AzureRefArch resource group, in which Panorama is already deployed
Resource Group	AzureRefArch-Shared	New resource group specifically for the shared design model
Storage account	azurerefarchv2shared	General purpose storage for VM-Series virtual file systems
Availability set	AzureRefArch-Shared-AS	New availability set for the VM-Series in the shared design model
Public IP for VM-Series 1	aras-vmfw1	Public IP for management interface
Public IP for VM-Series 2	aras-vmfw2	Public IP for management interface

3.1 Create Whitelist Network Security Group

Azure requires that an NSG must be applied on a subnet or NIC of your virtual machine resource, or traffic is not permitted to reach the resource when Standard SKU public IP addresses are associated with the resource.

Note

This guide uses Standard-SKU IP addresses in all procedures except where specifically noted.

This procedure creates a whitelist NSG for use with testing, which is applied to all dataplane subnets. The intent of this NSG is to simplify the troubleshooting process during early stages of deployment and testing.

Caution

An Allow-ALL NSG permits access to devices with public IP addresses from the Internet. We advise using more restrictive rules outside of a testing environment.

Step 1: In **Home > Network Security groups**, click **Add.**

Step 2: In the **Name** box, enter **AllowAll-Subnet**.

Step 3: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 4: Click **Create**.

Step 5: In **Home > Network Security groups**, click **Add.**

Step 6: In the **Name** box, enter **AllowAll-Subnet**.

Step 7: In the **Resource Group** section, choose **Use Existing,** and then select **AzureRefArch**.

Step 8: In **Home > Network security groups > AllowAll-Subnet**, in the SETTINGS section, click **Inbound security rules**.

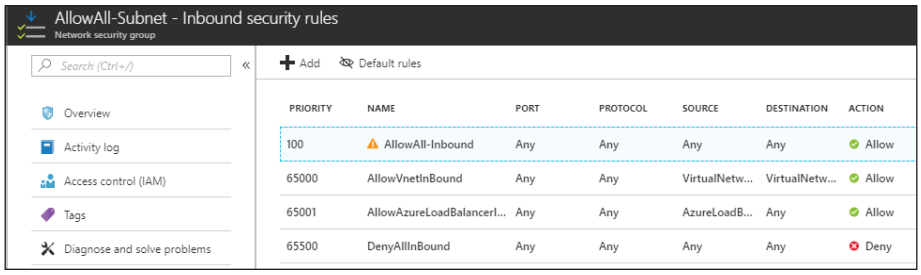
Step 9: Click **Add**. The Add inbound security rule pane appears.

Step 10: In the **Destination port ranges** box, enter *.

Step 11: In the **Name** box, enter **AllowAll-Inbound**.

Step 12: Click **Add**.

> **Note**
>
> Azure presents warning messages when the Network Security Group rules expose various ports to the Internet.



3.2 Add Address Space and Subnets to the Virtual Network

The existing virtual network (VNet) is modified to add additional IP address space and subnets. The first entry in Table 5 has already been configured in a prior procedure.

Table 5 Virtual network IP addressing and subnets

Address space	Subnet	Address range	Comments
192.168.1.0/24	Management	192.168.1.0/24	Initial address space, subnet and range (already configured).
172.16.0.0/23	Shared-Public	172.16.1.0/24	New subnet
10.5.0.0/16	Shared-Private Shared-Web Shared-Business Shared-DB Shared-VPN	10.5.0.0/24 10.5.1.0/24 10.5.2.0/24 10.5.3.0/24 10.5.15.0/24	New subnet New subnet New subnet New subnet New subnet

Step 1: In **Home > Virtual networks > AzureRefArch-VNET**, click **Address space.**

Step 2: In the **Add additional address space** box, enter **172.16.0.0/23**. A new box appears below.

Step 3: In the **Add additional address space** box, enter **10.5.0.0/16**, and then click **Save**.

Step 4: In **Home > Virtual networks > AzureRefArch-VNET**, click **Subnets.**

Step 5: Click **Subnet** to add a new subnet.

Step 6: In the **Name** box, enter **Shared-Public**.

Step 7: In the **Address Range (CIDR block)** box, enter **172.16.1.0/24**.

Step 8: Click in the **Network security group** section. In the **Resource** list, select **AllowAll-Subnet**, and click **OK**.

Step 9: Repeat Step 4 through Step 8 for all of the subnets listed as New subnet in Table 5.

Caution

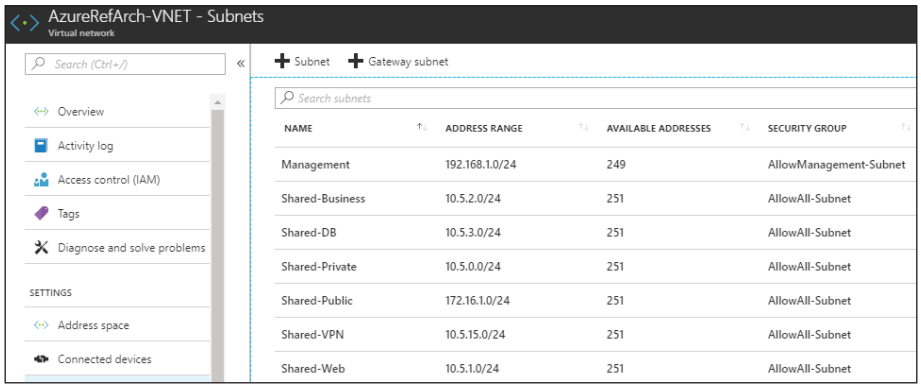
An NSG is not explicitly assigned to newly created subnets. You must assign an NSG to any subnet that uses an Azure Standard SKU public IP address.

Azure documentation states "If you do not have an NSG on a subnet or NIC of your virtual machine resource, traffic is not allowed to reach this resource."

During initial deployment and troubleshooting you may want to configure and use a whitelist "Allow All" NSG to simplify verification.

This guide does not provide further recommendations on how to properly craft and configure the NSGs.

Step 10: Verify all subnets are created with the correct IP ranges and security group.



3.3 Create the Resource Group for the Shared Design Model

This guide uses two resource groups, one has already been created for Panorama and common resources. This procedure creates a new resource group which contains all of the VM-Series devices and Azure load-balancer resources for the Shared Design Model.

> **Note**
>
> Resource groups are an administrative concept. Resources and devices in different resource groups can communicate if they are located within a common VNet, or if their VNets are interconnected.

Step 1: In **Home > Resource groups**, click **Add**.

Step 2: In the **Resource group name** box, enter **AzureRefArch-Shared** and select the desired values for **Subscription** and **Resource group location**. Click **Create**.

3.4 Create the Storage Account

The VM-Series firewalls require general purpose storage for their virtual file systems and bootstrapping.

Step 1: In **Home > Storage accounts**, click **Add.**

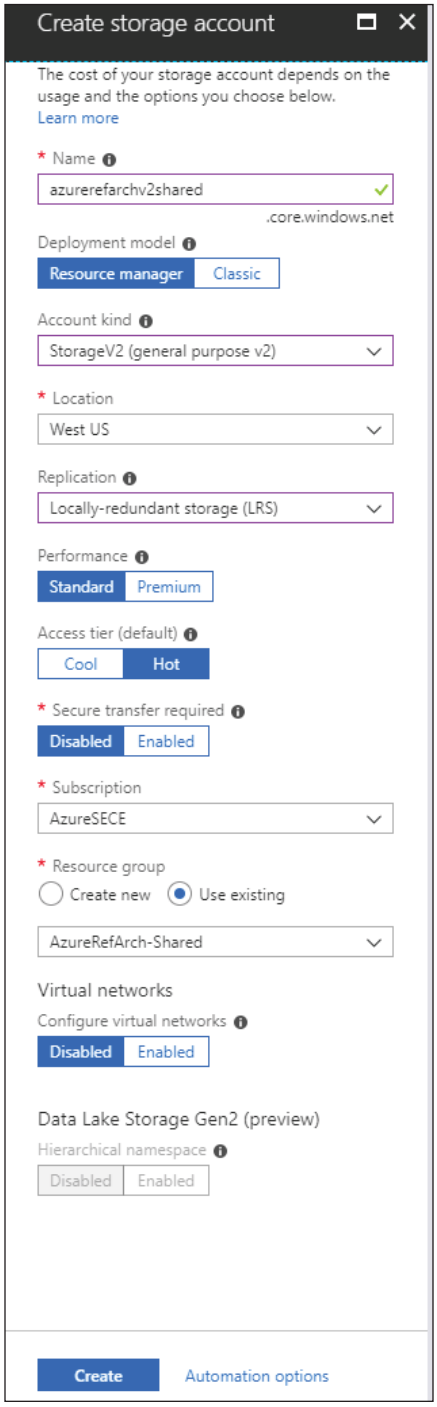
Step 2: In the **Name** box, enter **azurerefarchv2shared**.

Step 3: In the **Account kind** list, select **StorageV2 (general purpose v2)**.

Step 4: In the **Replication box**, select **Locally-redundant storage (LRS)**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 6: Click **Create**.



3.5 Create the Availability Set

The VM-Series resiliency model for Azure benefits from the use of an availability set with two fault domains. This ensures that the VM-Series systems are distributed across different fault domains.

> **Note**
>
> You can only configure an availability set on a virtual machine during its initial deployment. You can't modify a virtual machine's availability set configuration after the virtual machine is deployed.

Step 1: In **Home > Availability sets**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-Shared-AS**.

Step 3: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 4: In **Use managed disks**, select **No (classic)**. This is required for the ARM template.

Step 5: Click **Create**.

3.6 Create the Public IP Address for VM-Series

The VM-Series devices deployed on Azure are managed using public IP addresses unless on-site network connectivity has been established. The process to configure on-site network connectivity is included later in this guide.

This procedure creates a public IP address that is associated to the management interface of the VM-Series at deployment time. If necessary, this procedure is repeated to create additional public IP addresses for additional VM-Series devices. The parameters listed in Table 4 are used to complete this procedure.

Take note of the FQDN that is defined by adding the location specific suffix to your DNS name label. We recommend managing your devices using the DNS name rather than the public IP address, which may change.

Step 1: In **Home > Public IP addresses**, click **Add.**

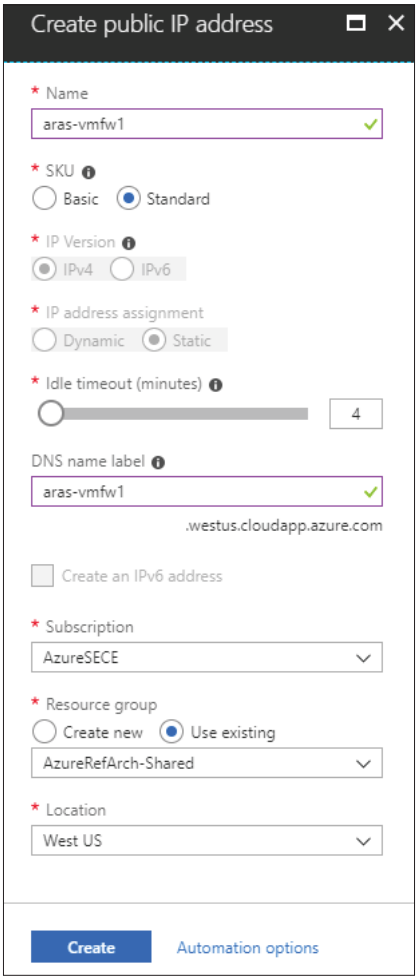
Step 2: In the **Name** box, enter **aras-vmfw1**.

Step 3: Select **Standard** SKU.

Step 4: In the **DNS name label** box, enter **aras-vmfw1**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

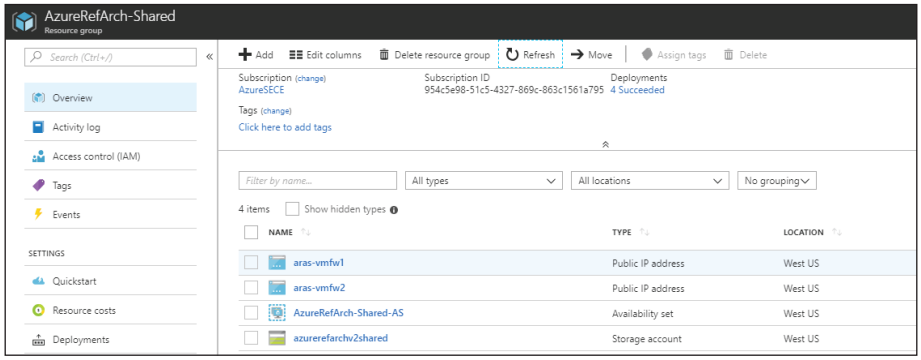
Step 6: Click **Create**.



3.7 Verify Resource Creation Completed

Some Azure deployments are time consuming and if any resources are missing, the deployment fails. It is quicker to verify that all of the necessary resources exist before proceeding with a deployment than waiting until a deployment fails.

Step 1: In **Home > Resource Groups**, select **AzureRefArch-Shared**.



Step 2: Verify that the resource group, public IP addresses, availability set, and storage account have been successfully created.

Procedures

Deploying VM-Series on Azure

The following procedures are completed using the Azure Resource Manager deployed from an Azure Resource Manager Template posted at GitHub. If you are already signed in to Azure at https://portal.azure.com, the deployment from GitHub uses the same session authorization.

Table 6 VM-Series deployment parameters

Parameter	Value	Comments
Resource group	AzureRefArch-Shared	Existing
Location	—	Tested in West US
VM name	ARAS-VMFW1 ARAS-VMFW2	First device Second device
Storage account name	azurerefarchv2shared	—
Storage account existing RG	AzureRefArch-Shared	—
Fw Av Set	AzureRefArch-Shared-AS	—

Table continued on next page

Continued table

Parameter	Value	Comments
VM size	Standard_D3_v2	https://www.paloaltonetworks.com/documentation/80/virtualization/virtualization/set-up-the-vm-series-firewall-on-azure/about-the-vm-series-firewall-on-azure/minimum-system-requirements-for-the-vm-series-on-azure
Public IP type	standard	Standard IP SKU required for use with Azure Standard load-balancer
Image version	latest	—
Image SKU	byol	—
Virtual network name	AzureRefArch-VNET	Uses AzureRefArch-VNET in resource group AzureRefarch
Virtual network address prefix	192.168.1.0/24	Match the initial IP address space from AzureRefArch-VNET
Virtual network existing RG name	AzureRefArch	—
Subnet0Name	Management	—
Subnet1Name	Shared-Public	—
Subnet2Name	Shared-Private	—
Subnet3Name	Shared-VPN	—
Subnet0Prefix	192.168.1.0/24	—
Subnet1Prefix	172.16.1.0/24	—
Subnet2Prefix	10.5.0.0/24	—
Subnet3Prefix	10.5.15.0/24	—
Subnet0Start Address	192.168.1.6 192.168.1.7	First device Second device (start assignment from .6)
Subnet1Start Address	172.16.1.6 172.16.1.7	First device Second device (start assignment from .6)
Subnet2Start Address	10.5.0.6 10.5.0.7	First device Second device (start assignment from .6)
Subnet3Start address	10.5.15.6 10.5.15.7	First device Second device (start assignment from .6)
Admin username	refarchadmin	—
Admin password	<password>	—
Public IP address name	aras-vmfw1 aras-vmfw2	First device Second device
Nsg name	None	NSG is applied at subnet level

4.1 Deploy VM-Series using Custom ARM Template

Repeat this procedure for all VM-Series. This guide assumes that at least two VM-Series devices are created.

The custom Azure Resource Manager template used in this procedure has been developed and validated specifically for this deployment guide.

For template details and features, see :
https://github.com/PaloAltoNetworks/ReferenceArchitectures/tree/master/Azure-1FW-4-interfaces-existing-environment

Use the parameters in Table 6 to deploy each VM-Series.

Step 1: Deploy the VM-Series by clicking on the **Deploy to Azure** button.

Step 2: In the Resource Group section, choose **Use Existing**, and then select **AzureRefArch-Shared**.

Step 3: In the **Vm Name** box, enter **ARAS-VMFW1**.

Step 4: In the **Storage Account Name** box, enter **azurerefarchv2shared**.

Step 5: In the **Storage Account Existing RG** box, enter **AzureRefArch-Shared**.

Step 6: In the **Fw Av Set** box, enter **AzureRefArch-Shared-AS**.

Step 7: In the **Vm Size** list, select **Standard_D3_v2**.

Step 8: In the **Public IP Type** list, select **standard**.

Step 9: In the **Image Version** list, select **latest**.

Step 10: In the **Image Sku** list, select **byol**.

Step 11: In the **Virtual Network Name** box, enter **AzureRefArch-VNET**.

Step 12: In the **Virtual Network Address Prefix** box, enter **192.168.1.0/24**.

Step 13: In the **Virtual Network Existing RG Name** box, enter **AzureRefArch**.

Step 14: In the **Subnet0Name** box, enter **Management**.

Step 15: In the **Subnet1Name** box, enter **Shared-Public**.

Step 16: In the **Subnet2Name** box, enter **Shared-Private**.

Step 17: In the **Subnet3Name** box, enter **Shared-VPN**.

Step 18: In the **Subnet0Prefix** box, enter **192.168.1.0/24**.

Step 19: In the **Subnet1Prefix** box, enter **172.16.1.0/24**.

Step 20: In the **Subnet2Prefix** box, enter **10.5.0.0/24**.

Step 21: In the **Subnet3Prefix** box, enter **10.5.15.0/24**.

Step 22: In the **Subnet0Start Address** box, enter **192.168.1.6**.

Step 23: In the **Subnet1Start Address** box, enter **172.16.1.6**.

Step 24: In the **Subnet2Start Address** box, enter **10.5.0.6**.

Step 25: In the **Subnet3Start Address** box, enter **10.5.15.6**.

Step 26: In the **Admin Username** box, enter **refarchadmin**.

Step 27: In the **Admin Password** box, enter the password.

Step 28: In the **Public IP Address Name** box, enter **aras-vmfw1**.

Step 29: In the **Network Security Group** box, enter **None**.

Step 30: Review the terms and conditions. If they are acceptable, select **I agree to the terms and conditions**.

Step 31: Click **Purchase**.

4.2 License VM-Series on Azure

Your VM-Series is now running on Azure but is unlicensed and using a factory default configuration.

This procedure assumes that you have a valid authorization code for your VM-Series device(s) and have registered the code on the Palo Alto Networks customer support portal (https://support.palotaltonetworks.com).

Step 1: Log in to your VM-Series device (example: https://aras-vmfw1.westus.cloudapp.azure.com).

Step 2: In **Device > Setup > Management > General Settings**, click the edit cog.

Step 3: In the **Domain** box, enter the domain suffix.

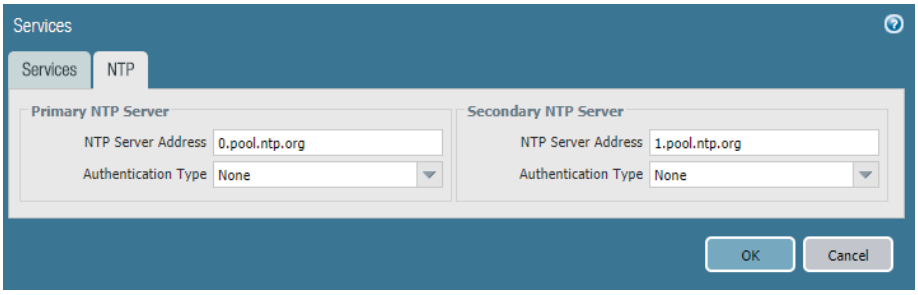
Step 4: In the **Time Zone** list, select the appropriate time zone (example: **US/Pacific**).

Step 5: In **Device > Setup > Services > Services**, click the edit cog.

Step 6: In the **Primary DNS Server** box, enter **168.63.129.16.**

Step 7: Change to the NTP tab. In the Primary NTP Server section **NTP Server Address** box, enter **0.pool.ntp.org**.

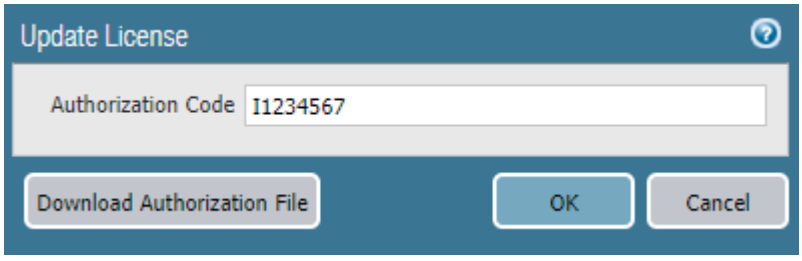
Step 8: In the Secondary NTP Server section **NTP Server Address** box, enter **1.pool.ntp.org**, and then click **OK**.



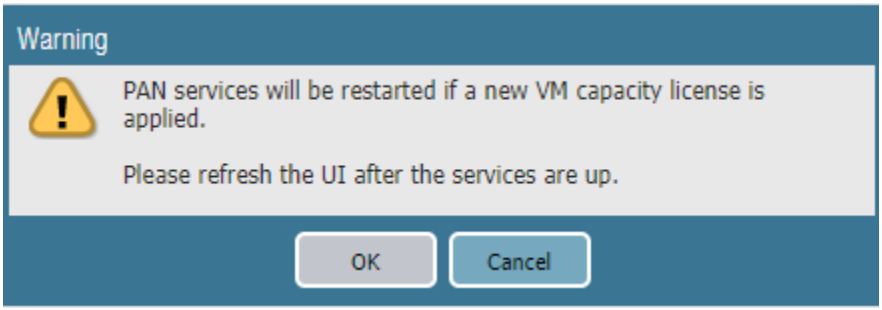
Step 9: Click **Commit**.

Step 10: In **Device > Licenses**, click **Activate feature using authorization code**.

Step 11: In the Update License window, in the **Authorization Code** box, enter the authorization code (example **I1234567**), and then click **OK**.



Step 12: Click OK to acknowledge the PAN services restart warning.



> **Note**
>
> The VM-Series services are restarted after the license is installed. Your management session to the VM-Series must be refreshed after the restart; this may take a few minutes.

4.3 Update Device Software

Step 1: Navigate to **Device** > **Software**.

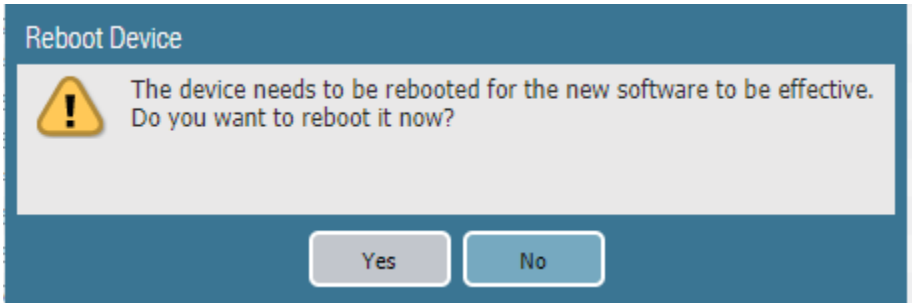
> **Note**
>
> If you receive an **Operation Failed** warning with the message **No update information available**, you may click **Close** to acknowledge. No action is required.

Step 2: In **Device** > **Software**, click **Check Now**.

Step 3: For version **8.1.2**, in the Actions column, click **Download**. Click **Close** when complete.

Step 4: After the status in the Available column has changed to **Downloaded**, in the **Action** column, click **Install**.

Step 5: When prompted to reboot the device, click **Yes**.



Step 6: After the reboot, in **Device > Dynamic Updates,** click **Check Now**.

Procedures

Preparing VM-Series Firewall Configurations Using Panorama

Panorama provides a number of tools for centralized administration:

- **Hierarchical device groups**—Panorama manages common policies and objects through hierarchical device groups. Multi-level device groups are used to centrally manage the policies across all deployment locations with common requirements
- **Templates/template stacks**—Panorama manages common device and network configuration through templates. You can use templates to manage configuration centrally and then push the changes to all managed firewalls. This approach avoids your making the same individual firewall change repeatedly across many devices. To make things easier, you can stack templates and use them as building blocks for device and network configuration.

5.1 Configure Device Group

This guide uses a single device group specific to the shared design model. The objects and policies are created in the procedures that require them.

Step 1: In **Panorama > Device Groups**, click **Add**.

Step 2: In the **Name** box, enter **Azure-Shared**.

Step 3: In the **Description** box, enter a valid description.

Step 4: In the **Parent Device Group** box, verify the value is set to **Shared**, and then click **OK**.

5.2 Configure Panorama Templates and Device Group

The templates include configuration for all functions that are common across all the VM-Series devices in the shared design model.

Two templates are used. The **Azure-3-Zone** template includes firewall networking functions including interfaces, zones, and virtual routers. The **Logging Service** template includes device functions to enable the Logging Service. Both templates are applied to devices using a Panorama template stack, which logically merges the assigned templates and associates them with the relevant devices.

This procedure creates the templates that are used for subsequent procedures in this guide. The specific configurations for these templates are created within the relevant procedures. You create the template stack later in this guide, when associating the first device to the templates.

Step 1: In **Panorama > Templates**, click **Add**.

Step 2: In the **Name** box, enter **Azure-3-Zone**.

Step 3: In the **Description** box, enter a valid description, and then click **OK**.

Step 4: In **Panorama > Templates**, click **Add**.

Step 5: In the **Name** box, enter **Logging Service**.

Step 6: In the **Description** box, enter a valid description, and then click **OK**.

Step 7: On the **Commit** menu, click **Commit to Panorama**.

Step 8: Verify the additional tabs for Device Groups (Policies and Objects) and Templates (Network and Device) are now visible on the Panorama management portal.

> **Note**
>
> You may need to refresh the screen on the secondary Panorama and navigate to a different tab before the additional tabs becomes visible.

5.3 Select Azure-3-Zone Template for Configuration

Step 1: Log in to your Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com)

Step 2: Navigate to **Templates > Device**.

Step 3: In the **Template** list, select **Azure-3-Zone**.

5.4 Configure Device Parameters

This procedure ensures that DNS and NTP are configured consistently across all devices.

Step 1: In **Templates > Device > Setup > Services > Global > Services**, click the Edit cog.

Step 2: In the **Primary DNS Server** box, enter **168.63.129.16**

Step 3: Change to the **NTP** tab. In the Primary NTP Server section **NTP Server Address** box, enter **0.pool.ntp.org**.

Step 4: In the Secondary NTP Server section **NTP Server Address** box, enter **1.pool.ntp.org,** and then click **OK**.

5.5 Create Zones and Virtual Routers

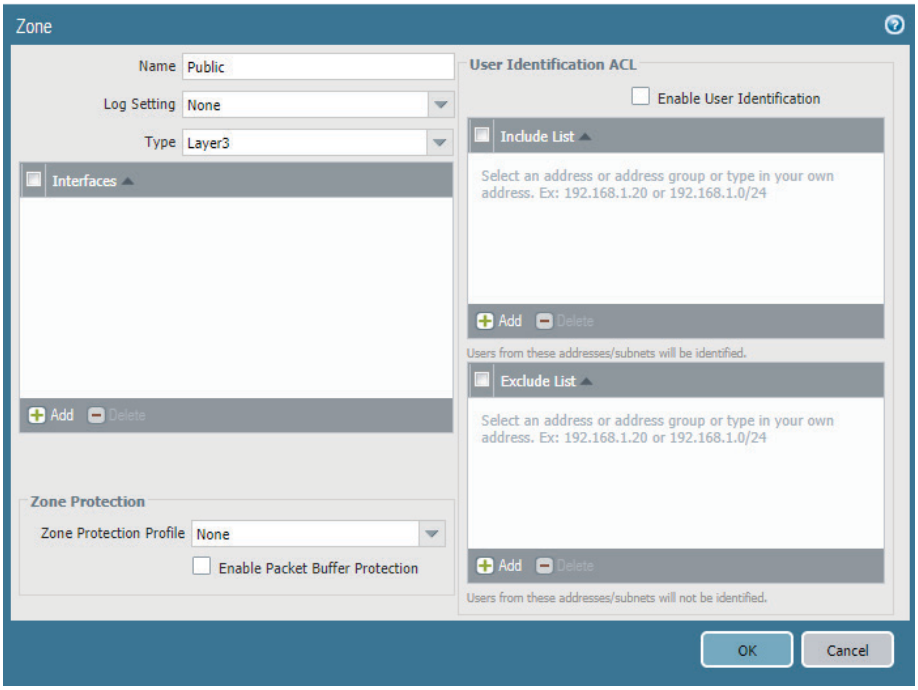
Table 7 Zone and virtual router settings

Zone name	Zone type	Virtual router name
Public	Layer3	VR-Public
Private	Layer3	VR-Private
VPN	Layer3	VR-VPN

Step 1: In **Templates > Network > Zones**, click **Add**. The Zone window appears.

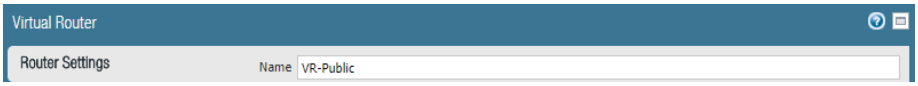
Step 2: In the **Name** box, enter **Public**.

Step 3: In the **Type** list, select **Layer3**, and then click **OK**.



Step 4: In **Templates > Network > Virtual Routers**, click **Add**. The Virtual Router configuration window appears.

Step 5: In the **Name** box, enter **VR-Public**, and then click **OK**.



Step 6: Repeat Step 1 through Step 5 for all rows in Table 7.

5.6 Create Management Profiles

The load-balancer health-checks use HTTPS probes towards the firewall's dataplane interfaces. The firewall blocks responses to these probes by default. Interface management profiles are used to override the default block operation.

> **Note**
>
> A single management profile may be applied to multiple interfaces. We recommend separate management profiles per interface, if required, to allow for different management policies.

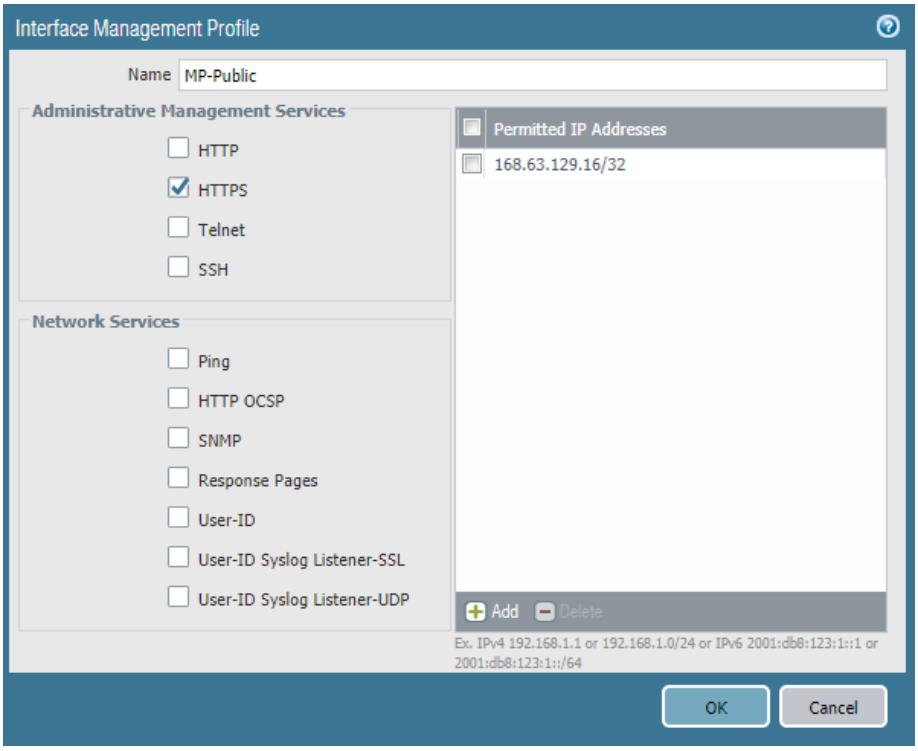
Step 1: In **Templates > Network > Network Profiles > Interface Mgmt,** click **Add**. The Interface Management Profile configuration window appears.

Step 2: In the **Name** box, enter **MP-Public**.

Step 3: In the Administrative Management Services section, select **HTTPS.**

Step 4: In the Permitted IP Addresses pane, click **Add**.

Step 5: Enter **168.63.129.16/32**, and then click **OK**.



Step 6: Repeat Step 1 through Step 5 for **MP-Private** and **MP-VPN**.

5.7 Create Ethernet Interfaces

> **Note**
>
> Although the VM-Series is not a modular hardware platform, assign interfaces to Slot 1 when using Panorama templates for the VM-Series.

Table 8 Azure-3-zone template interface settings

Slot	Interface	Interface type	Virtual router	Security zone	IPv4	Management profile
Slot 1	ethernet1/1	Layer3	VR-Public	Public	DHCP Client	MP-Public
Slot 1	ethernet1/2	Layer3	VR-Private	Private	DHCP Client	MP-Private
Slot 1	ethernet1/3	Layer3	VR-VPN	VPN	DHCP Client	MP-VPN

Step 1: In **Templates** > **Network** > **Interfaces** > **Ethernet,** click **Add Interface**. The Ethernet Interface configuration window appears.

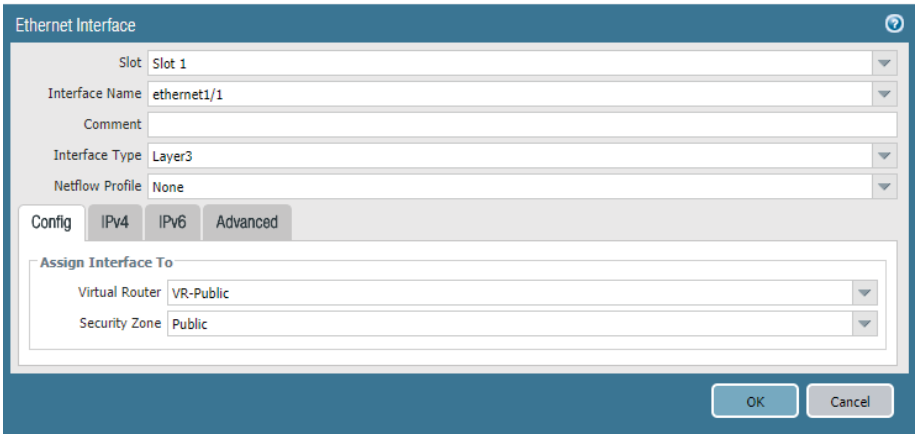
Step 2: In the **Slot** list, select **Slot 1**.

Step 3: In the **Interface Name** list, select **ethernet1/1**.

Step 4: In the **Interface Type** list, select **Layer3**.

Step 5: In the **Assign Interface To Virtual Router** list, select **VR-Public**.

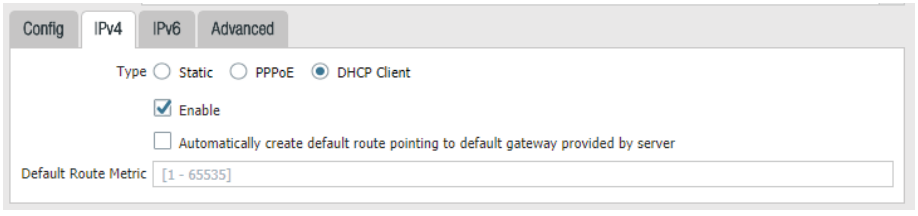
Step 6: In the **Assign Interface To Security Zone** list, select **Public**.



Step 7: Change to the IPv4 tab.

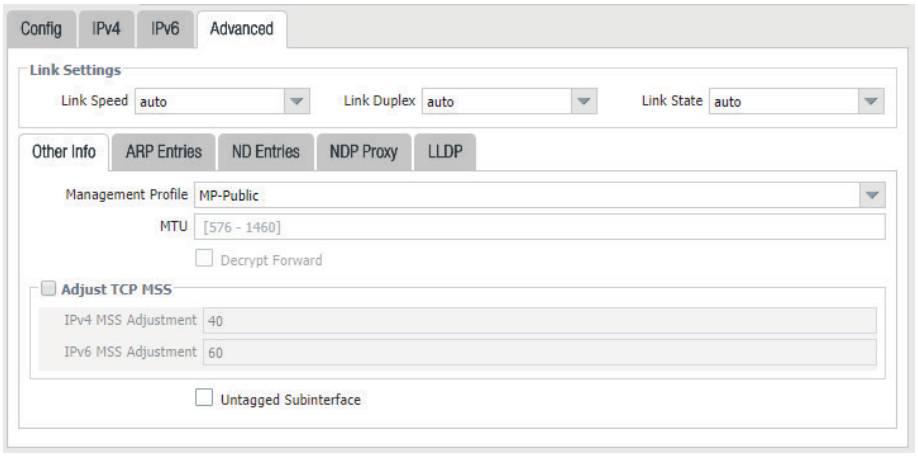
Step 8: Select **DHCP client**.

Step 9: Select **Enable** and clear **Automatically create default route pointing to default gateway provided by server**.



Step 10: Change to the Advanced tab.

Step 11: In the **Management Profile** list, select **MP-Public**, and then click **OK**.



Step 12: Click **Yes** to accept the interface management profile **Warning**.

Step 13: Repeat Step 1 through Step 11 for all rows in Table 8.

5.8 Add Static Routes to Virtual Routers

Each of the three virtual routers requires static route configuration. Repeat this procedure three times, using the values in the appropriate table:

- When configuring static routes for **VR-Public**, use the values in Table 9.
- When configuring static routes for **VR-Private**, use the values in Table 10.
- When configuring static routes for **VR-VPN**, use the values in Table 11.

Table 9 VR-Public IPv4 static routes

Name	Destination prefix	Interface	Next-hop	Next-hop value
default	0.0.0.0/0	ethernet1/1	IP Address	172.16.1.1
Azure-Probe	168.63.129.16/32	ethernet1/1	IP Address	172.16.1.1
Net-10.5.0.0	10.5.0.0/16	None	Next VR	VR-Private

Table 10 VR-Private IPv4 static routes

Name	Destination prefix	Interface	Next-hop	Next-hop value
default	0.0.0.0/0	None	Next VR	VR-External
Azure-Probe	168.63.129.16/32	ethernet1/2	IP Address	10.5.0.1
Net-10.5.1.0	10.5.1.0/24	ethernet1/2	IP Address	10.5.0.1
Net-10.5.2.0	10.5.1.0/24	ethernet1/2	IP Address	10.5.0.1
Net-10.5.3.0	10.5.1.0/24	ethernet1/2	IP Address	10.5.0.1
Net-10.6.0.0	10.6.0.0/24	None	Next VR	VR-VPN

Table 11 VR-VPN IPv4 static routes

Name	Destination prefix	Interface	Next-hop	Next-hop value
Azure-Probe	168.63.129.16/32	ethernet1/3	IP Address	10.5.15.1
Net-10.6.0.0	10.6.0.0/24	ethernet1/3	IP Address	10.5.15.1
Net-10.5.0.0	10.5.0.0/16	None	Next VR	VR-Private

Step 1: In **Templates > Network > Virtual Routers**, click **VR-Public**. The Virtual Router configuration window appears.

Step 2: On the Static Routes tab, click **Add**. The Virtual Router —Static Route—IPv4 configuration window appears.

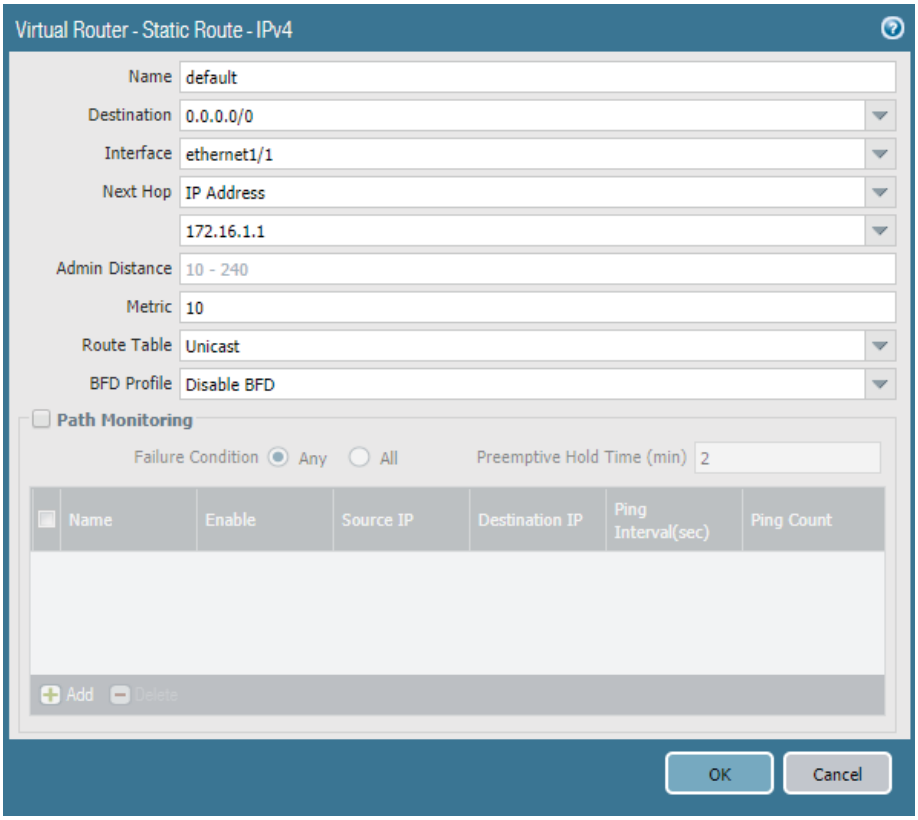
Step 3: In the **Name** box, enter **default**.

Step 4: In the **Destination** box, enter **0.0.0.0/0**.

Step 5: In the **Interface** list, select **ethernet1/1**.

Step 6: In the **Next Hop** list, select **IP Address** and enter **172.16.1.1**, click **OK**, and then click **OK** again.

Step 7: After adding all routes for this virtual router, click **OK** to close the Virtual Router window.



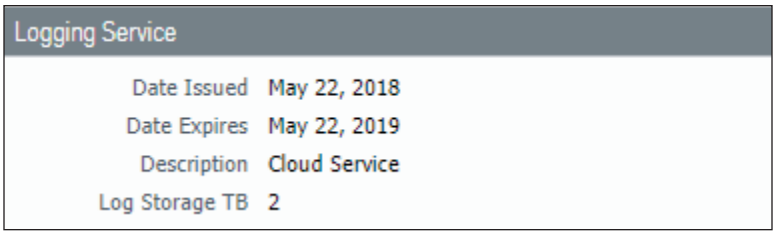
5.9 Commit Changes

Step 1: On the **Commit** menu, click **Commit to Panorama**.

5.10 Retrieve and Verify Logging Service License

Step 1: In **Panorama > Licenses**, click **Retrieve license keys from license server**.

Step 2: Verify that the Logging Service license is active.



5.11 Configure Logging-Service Template

Step 1: Navigate to **Templates** > **Device**.

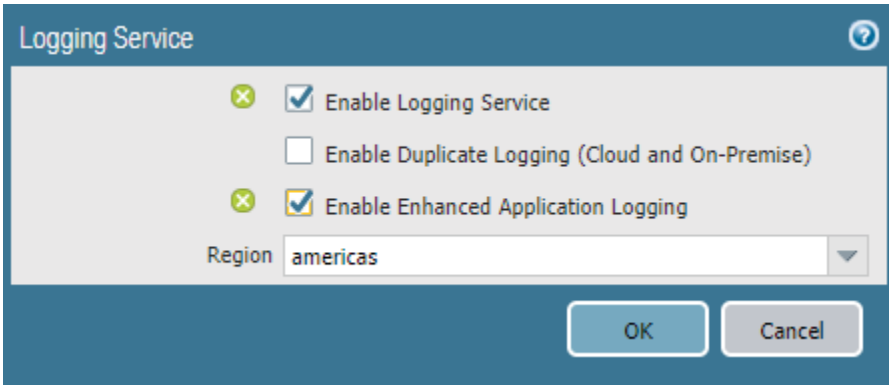
Step 2: In the **Template** list, select **Logging-Service**.

Step 3: In **Templates** > **Device** > **Setup** > **Management** > **Logging Service**, click the Edit cog.

Step 4: Select **Enable Logging Service**.

Step 5: Select **Enable Enhanced Application Logging**.

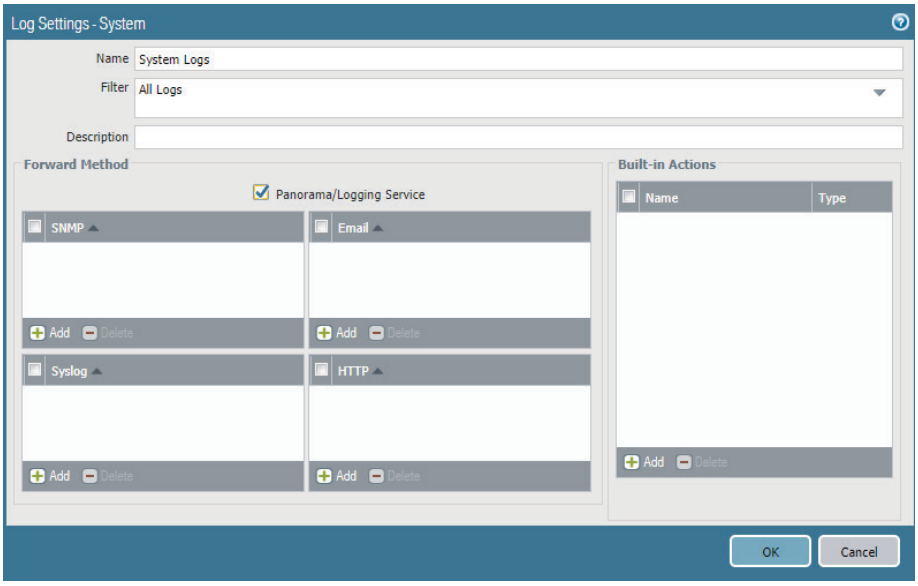
Step 6: In **Region** list, select **americas**, and then click **OK**.



Step 7: In **Templates** > **Device** > **Log Settings** > **System**, click **Add**. The Log Settings—System configuration window appears.

Step 8: In the **Name** box, enter **System Logs**.

Step 9: Select **Panorama/Logging Service**, and then click **OK**.



Step 10: In **Templates > Device > Log Settings > Configuration**, click **Add**. The Log Settings—Configuration window appears.

Step 11: In the **Name** box, enter **Configuration Logs**.

Step 12: Select **Panorama/Logging Service**, and then click **OK**.

Step 13: On the **Commit** menu, click **Commit to Panorama**.

Procedures

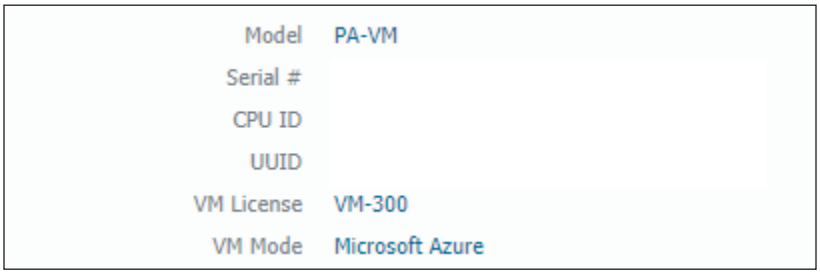
Managing VM-Series with Panorama

6.1 Add VM-Series to Panorama

This procedure is required for each new VM-Series device that is added to Azure. Later in this guide, you perform the procedure to automatically bootstrap the VM-Series to register with Panorama.

Step 1: Log in to your VM-Series device (example: https://aras-vmfw1.westus.cloudapp.azure.com).

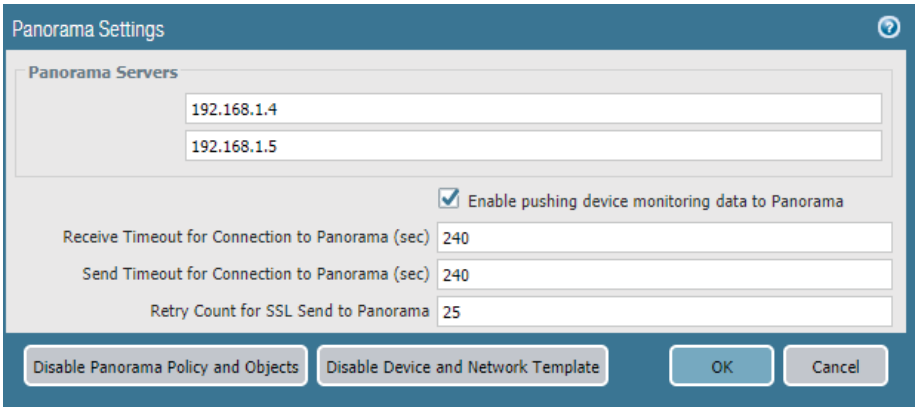
Step 2: In **Dashboard > General Information**, record the **Serial #**.



Step 3: In **Device > Setup > Management > Panorama Settings**, click the edit cog.

Step 4: In the Panorama Servers section, in the top box, enter **192.168.1.4**.

Step 5: If you are using Panorama High Availability, in the bottom box, enter **192.168.1.5**, and then click **OK**.

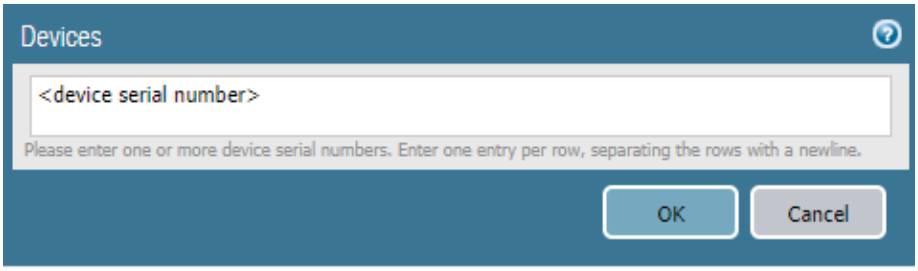


Step 6: Click **Commit**.

Step 7: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com)

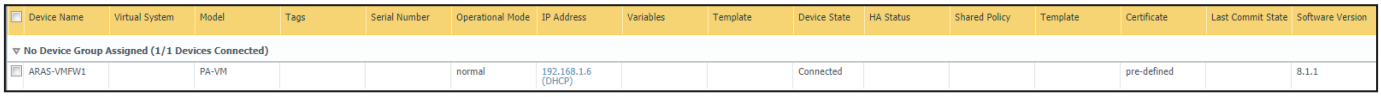
Step 8: In **Panorama > Managed Devices > Summary**, click **Add**.

Step 9: In the **Devices** box, enter the serial number from Step 2, and then click **OK**.



Step 10: On the **Commit** menu, click **Commit to Panorama**.

Step 11: In **Panorama > Managed Devices > Summary**, verify that the device state of the VM-Series is **Connected**. It may take a few minutes for the state to change.



Device Name	Virtual System	Model	Tags	Serial Number	Operational Mode	IP Address	Variables	Template	Device State	HA Status	Shared Policy	Template	Certificate	Last Commit State	Software Version
No Device Group Assigned (1/1 Devices Connected)															
ARAS-VMFW1		PA-VM			normal	192.168.1.6 (DHCP)			Connected				pre-defined		8.1.1

6.2 Add VM-Series to Template Stack and Device Group

This procedure adds devices to the template stack and device groups. The template stack is created and configured when you add the first VM-Series device only.

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Option 1: Template stack does not already exist

This option creates a template stack.

Step 1: In **Panorama > Templates**, click **Add Stack**.

Step 2: In the **Name** box, enter **Azure-Shared-Model**.

Step 3: In the Templates pane, click **Add**. Enter **Azure-3-Zone**.

Step 4: In the Templates pane, click **Add**. Enter **Logging-Service**.

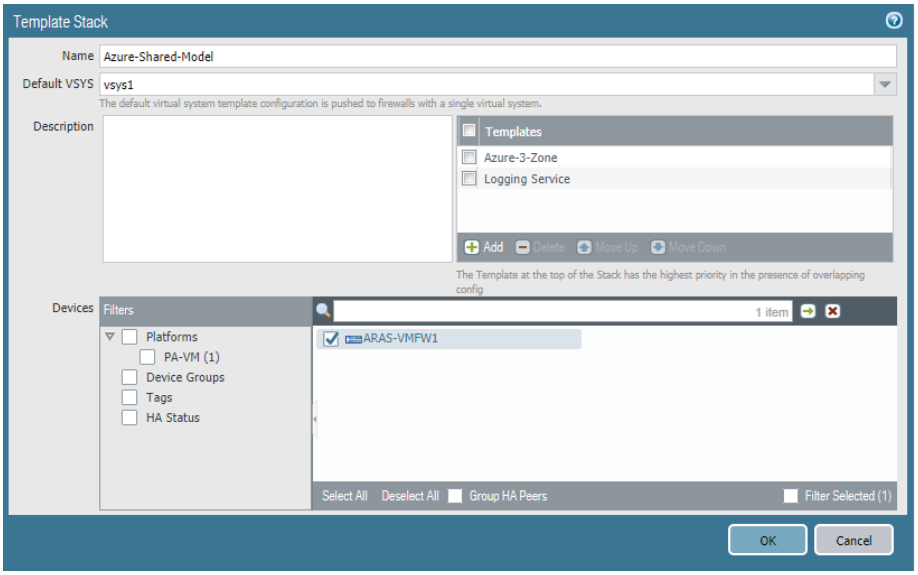
Option 2: Template stack has already been created

This option modifies the existing template stack.

Step 1: In **Panorama > Templates**, click **Azure-Shared-Model**.

Proceed with configuring the template stack.

Step 2: In the Devices pane, select **ARAS-VMFW1** to assign it to the template stack, and then click **OK**.

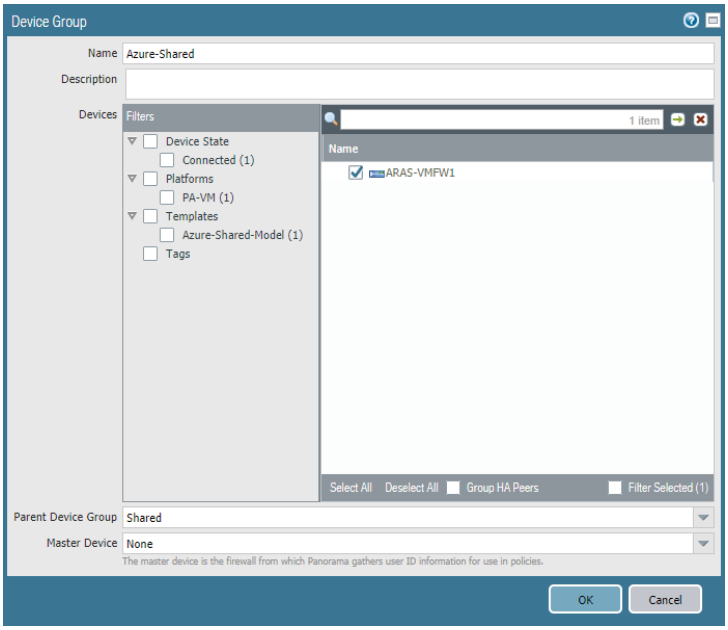


Step 3: On the **Commit** menu, click **Commit and Push**.

The local configuration on each VM-Series should now reflect the template-based configuration that was created on Panorama. This includes interfaces, zones, virtual routers, management profiles, and Logging Service.

Step 4: In **Panorama > Device Groups**, click **Azure-Shared**.

Step 5: In the Devices pane, select **ARAS-VMFW1** to assign it to the device group, and then click **OK**.



Step 6: On the **Commit** menu, click **Commit and Push**.

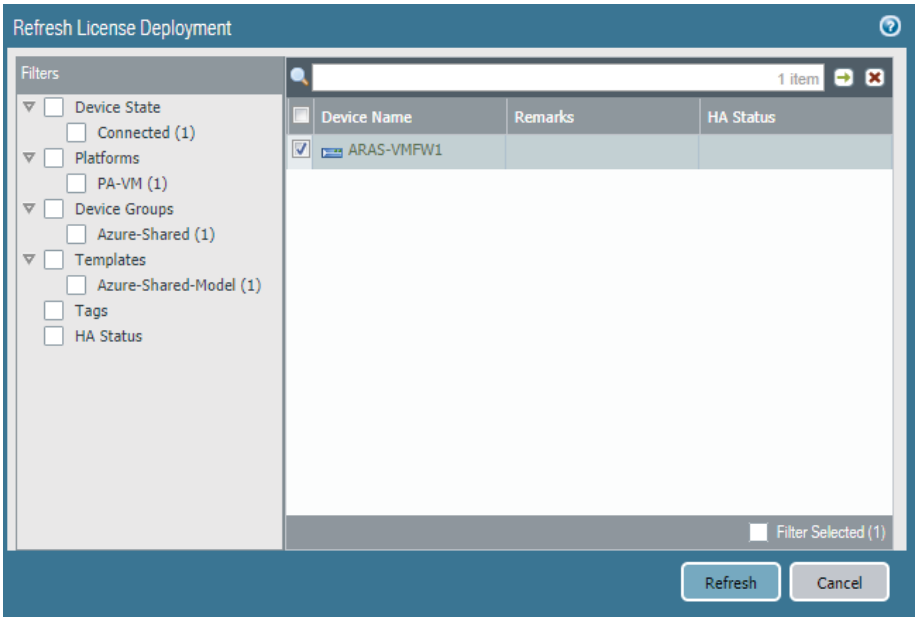
Device group policies and objects are created in procedures later in this guide. The policies and objects for the **Azure-Shared** device group are automatically pushed to the local devices from Panorama as they are created.

6.3 Refresh License to Enable Logging Service

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: In **Panorama > Device Deployment > Licenses**, click **Refresh**. The Refresh License Deployment window appears.

Step 3: In the **Device Name** column, select the VM-Series, and then click **Refresh**.



Step 4: Verify the details include **Successfully installed license 'Logging Service,'** and then click **Close**.

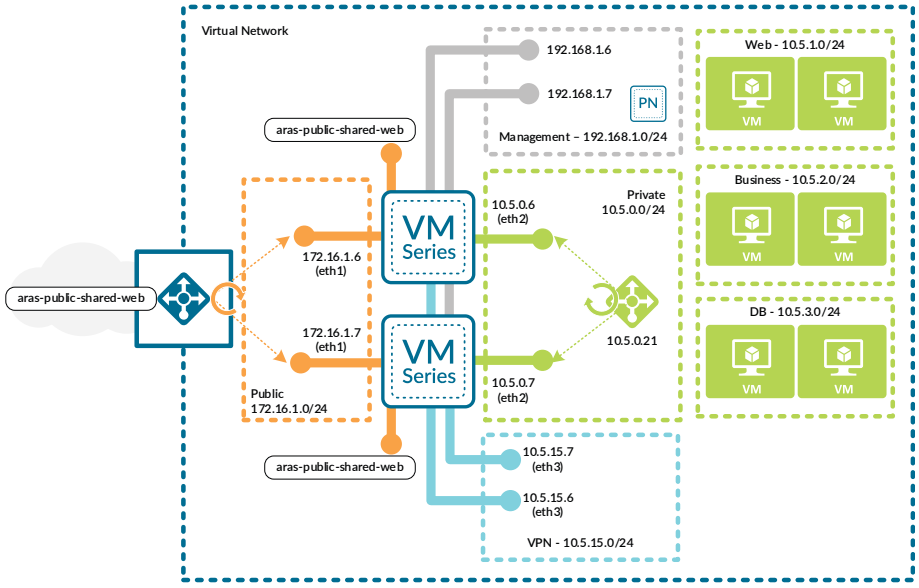
Device Name	Status	Result	Progress	Details
ARAS-VMFW1	Completed	Successful	100%	Successfully installed license 'Threat Prevention' on ARAS-VMFW1. Successfully installed license 'PAN-DB URL Filtering' on ARAS-VMFW1. Successfully installed license 'GlobalProtect Gateway' on ARAS-VMFW1. Successfully installed license 'GlobalProtect Portal' on ARAS-VMFW1. Successfully installed license 'WildFire License' on ARAS-VMFW1. Successfully installed license 'BrightCloud URL Filtering' on ARAS-VMFW1. Successfully installed license 'PA-VM' on ARAS-VMFW1. Successfully installed license 'Logging Service' on ARAS-VMFW1.

Deployment Details for Azure Networking and Firewall Policies

The VM-Series devices do not actively forward traffic within Azure until they have been integrated into Azure networking and the firewall policies for each traffic profile have been created. You must complete the complementary procedure groups in order support the traffic profiles in the shared design model.

Resiliency for the traffic profiles is implemented using Azure user-defined routes and Azure Load-Balancer these procedures are included in the first procedure group. The traffic profiles within the shared design model each require a unique firewall policy. A second procedure group configures the policies required for each traffic profile.

Figure 6 Azure networking for shared design model



Procedures

Configuring Azure Networking and Services

The following procedures are completed using the Azure Resource Manager. Sign in to Azure at https://portal.azure.com.

7.1 Create the Public IP Address for the Azure Public Load-Balancer

This procedure creates a public IP address that is assigned as the frontend IP address for the Azure public load-balancer for inbound traffic to the web server resources.

Note the FQDN that is defined by adding the location specific suffix to your DNS name label. You use this value in a subsequent procedure when you create Panorama IP address objects for the Inbound Access traffic profile.

Step 1: In **Home > Public IP addresses**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-Public-Shared-Web**.

Step 3: Select **Standard SKU**.

Step 4: In the **DNS name label** box, enter **aras-public-shared-web**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

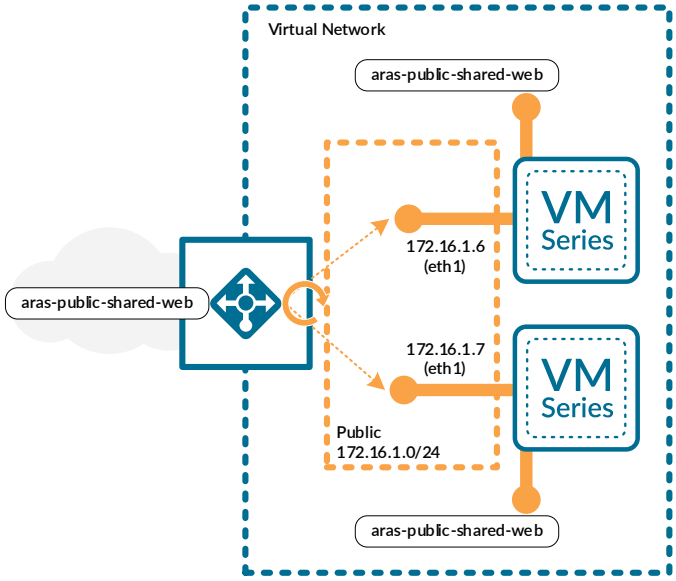
Step 6: Click **Create**.

Step 7: Record the value for the FQDN (example: **aras-public-shared-web.westus.cloudapp.azure.com**).

7.2 Create the Azure Public Load-Balancer

You create the Azure Public Load-Balancer with a single public frontend IP address and associate it with the public interfaces of a pair of VM-Series firewalls using floating IP.

Figure 7 Azure public load-balancer



Step 1: In **Home > Load Balancers**, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-Shared-Public**.

Step 3: In the Type section, select **Public**.

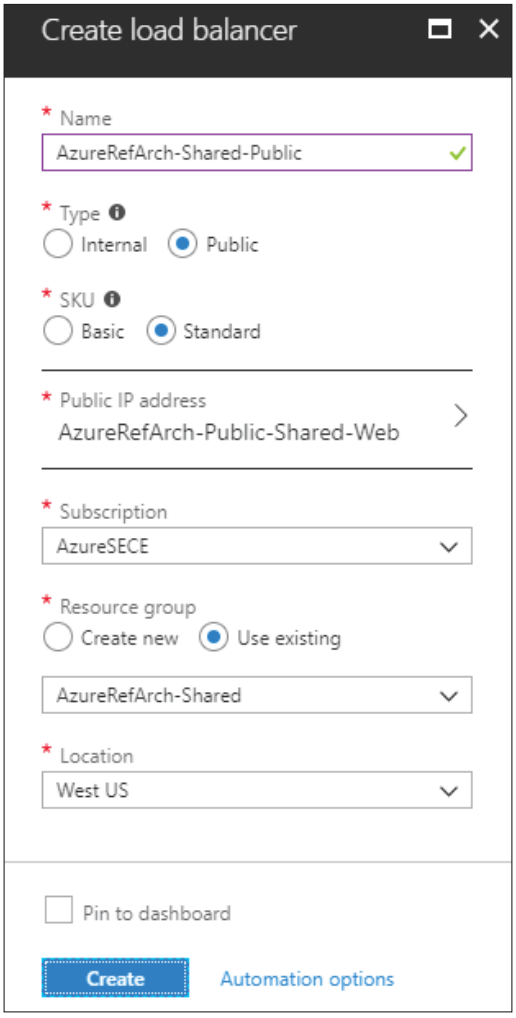
Step 4: In the SKU section, select **Standard**.

Step 5: Click the **Public IP address** section, and then select **AzureRefArch-Public-Shared-Web**.

This address is associated with the default frontend IP configuration (**LoadBalancerFrontEnd**). You may add additional frontend IP addresses to the load-balancer if necessary after it has been created.

Step 6: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 7: Click **Create**.



7.3 Configure the Azure Public Load-Balancer

This procedure assumes that all of the VM-Series firewalls that are to be associated to the load-balancer have already been deployed and does not include the steps to add a new firewall to an existing backend pool.

Step 1: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Public**, click **Health probes**.

Step 2: Click **Add**.

Step 3: In the **Name** box, enter **HTTPS-Probe**.

Step 4: In the **Port** box, enter **443**, and then click **OK**.

Step 5: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Public**, click **Backend pools**.

Step 6: Click **Add**.

Step 7: In the **Name** box, enter **Firewall-Layer**.

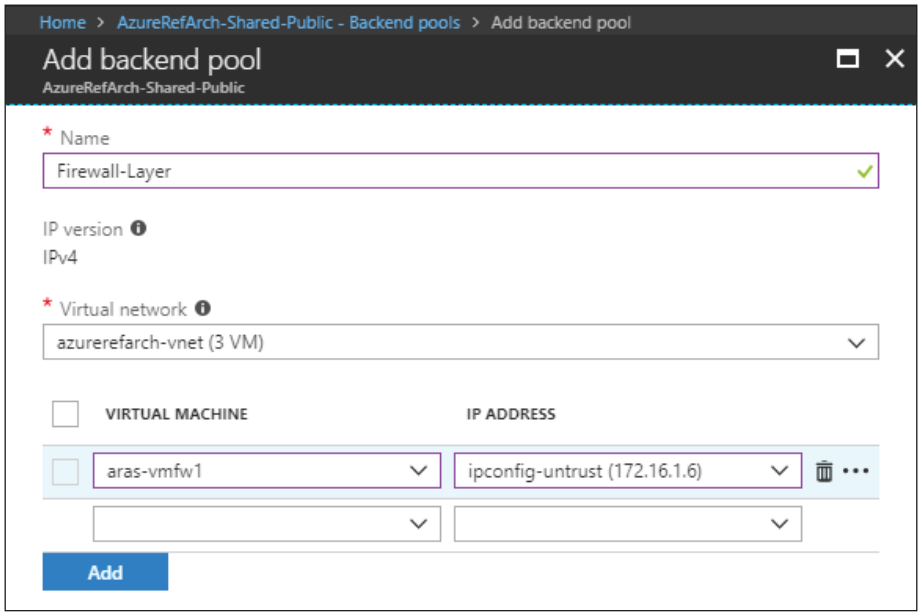
Step 8: In the **Virtual network** list, select **azurerefarch-vnet (X VM)**, where X is the total number of VM-Series firewalls and Panorama virtual machines already deployed in your VNet.

Step 9: In the **VIRTUAL MACHINE** column, select a VM-Series to be added to this backend pool (example: **aras-vm-fw1**).

Step 10: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Public** subnet. (example: **ipconfig-untrust**).

Step 11: Repeat Step 9 and Step 10 for all VM-Series firewalls that are to be assigned to this backend pool.

Step 12: Click **Add**.



Next, you create a load balancing rule for each required TCP port (Example: **TCP/80**, **TCP/443**).

Step 13: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Public**, click **Load balancing rules**.

Step 14: Click **Add**.

Step 15: In the **Name** box, enter **AzureRefArch-Shared-Public-Web-80**.

Step 16: In the **Frontend IP address** list, select **LoadBalancerFrontEnd**.

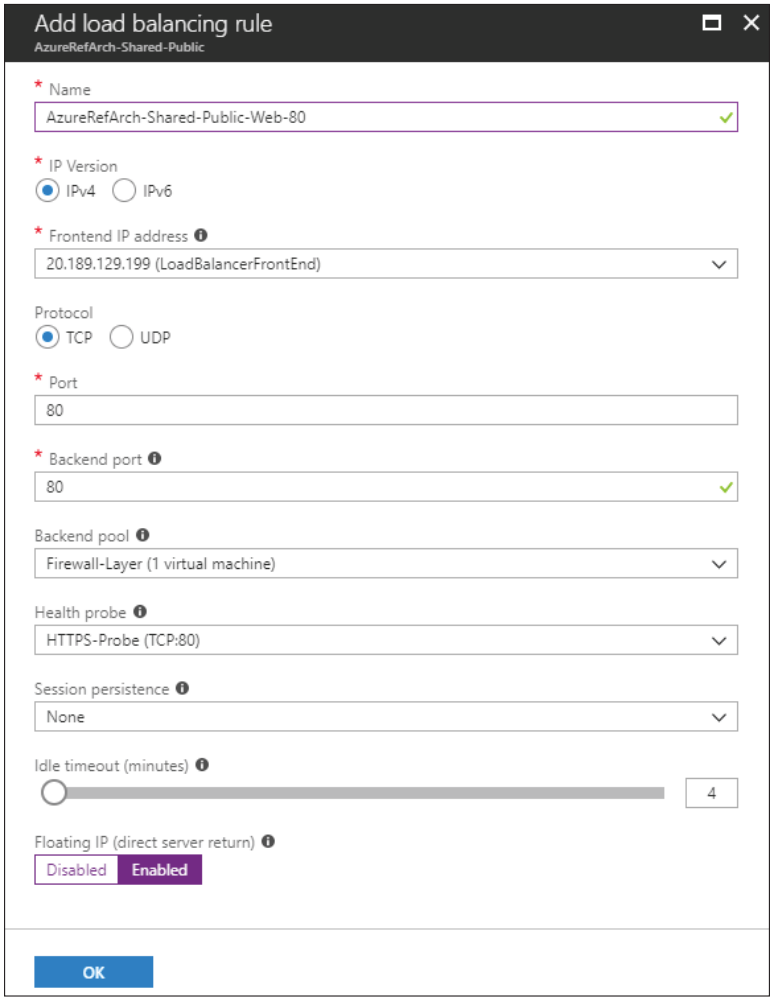
Step 17: In the **Port** box, enter **80**.

Step 18: In the **Backend port** box, enter **80**.

Step 19: In the **Backend pool** list, select **Firewall-Layer**.

Step 20: In the **Health probe** list, select **HTTPS-Probe**.

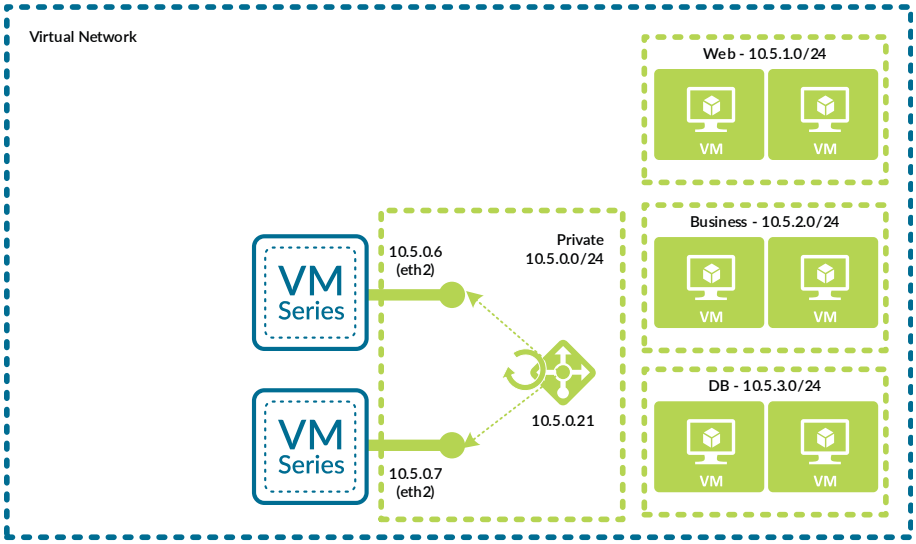
Step 21: In the **Floating IP (direct server return)** section, select **Enabled**, and then click **OK**.



7.4 Create the Azure Internal Load-Balancer

You create the Azure Internal Load-Balancer with a single private frontend IP address and associate it with the private interfaces of a pair of VM-Series firewalls.

Figure 8 Azure internal load-balancer for outbound access



You use the frontend IP address as the routing next-hop for destination addresses on the public networks and the internet.

Step 1: In **Home** > **Load Balancers**, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-Shared-Internal**.

Step 3: In the Type section, select **Internal**.

Step 4: In the SKU section, select **Standard**.

Step 5: Click the **Virtual network** *Choose a virtual network* section, and select **AzureRefArch-VNET**.

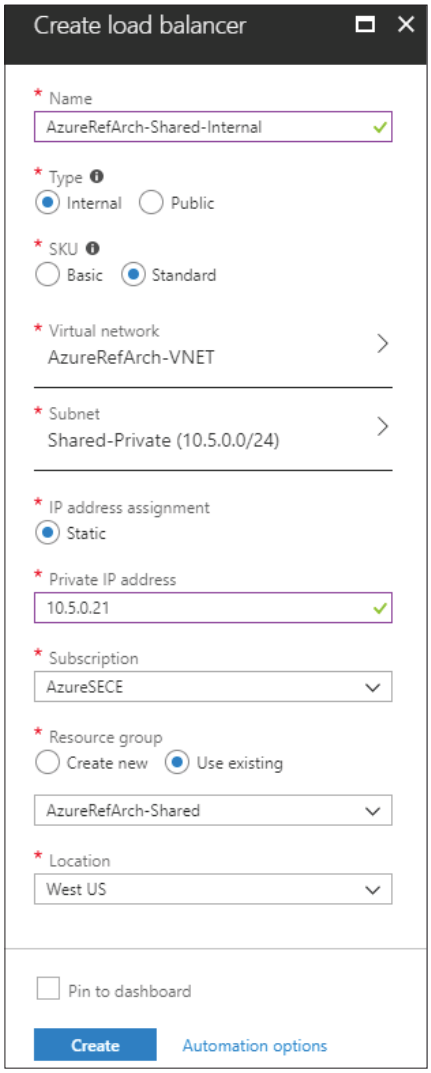
Step 6: Click the **Subnet** *Choose a subnet* section, and select **Shared-Private**.

Step 7: In the IP address assignment section, select **Static**.

Step 8: In the **Private IP address** box, enter **10.5.0.21**. This address is associated with the default frontend IP configuration (**LoadBalancerFrontEnd**), which is used for outbound access. Additional frontend IP addresses may be added to the load-balancer if necessary after it has been created.

Step 9: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 10: Click **Create**.



7.5 Configure the Azure Internal Load-Balancer for Outbound Access

Step 1: In Home > Load Balancers > **AzureRefArch-Shared-Internal**, click Health probes.

Step 2: Click Add.

Step 3: In the Name box, enter **HTTPS-Probe**.

Step 4: In the **Port** box, enter **443**, and then click **OK**.

Step 5: In **Home > Load Balancers > AzureRefArch-Shared-Internal**, click **Backend pools**.

Step 6: Click **Add**.

Step 7: In the **Name** box, enter **Firewall-Layer-Private**.

Step 8: In the **Virtual network** list, select **azurerefarch-vnet (X VM)**, where X is the total number of VM-Series firewalls and Panorama virtual machines already deployed in your VNet.

Step 9: In the **VIRTUAL MACHINE** column, select a VM-Series to be added to this backend pool (example: **aras-vm-fw1**).

Step 10: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Private** subnet. (example: **ipconfig-trust**).

Step 11: Repeat Step 9 and Step 10 for all VM-Series firewalls that are to be assigned to this backend pool.

Step 12: Click **Add**.

Step 13: In **Home > Load Balancers > AzureRefArch-Shared-Internal**, click **Load balancing rules**.

Step 14: Click **Add**.

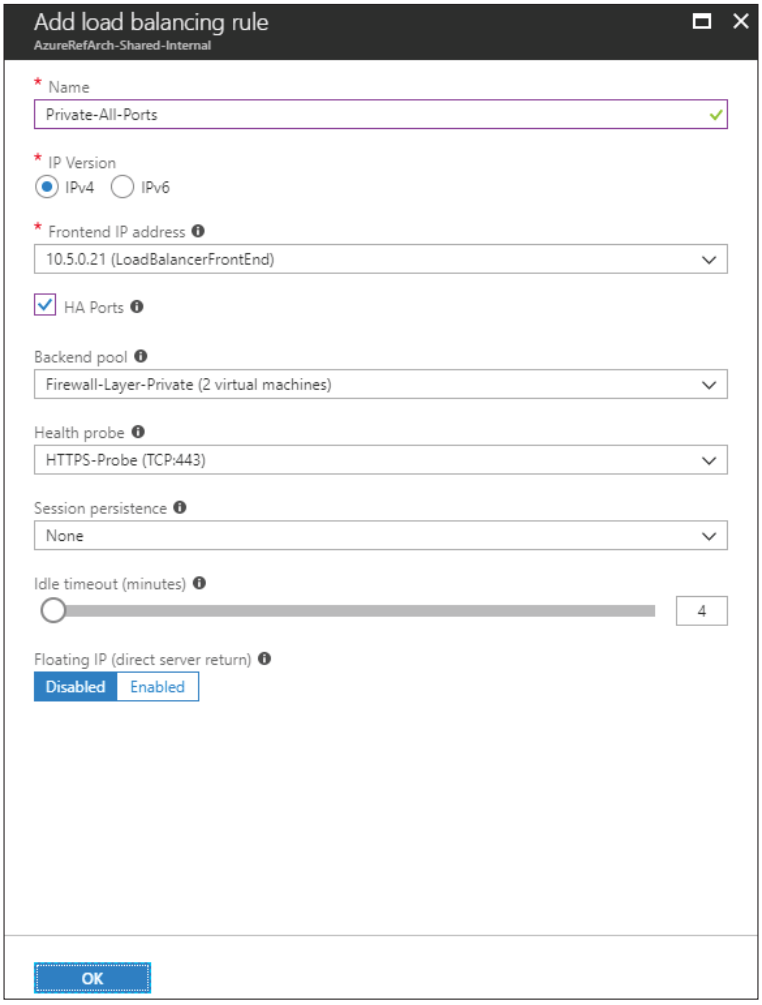
Step 15: In the **Name** box, enter **Private-All-Ports**.

Step 16: In the **Frontend IP address** list, select **LoadBalancerFrontEnd**.

Step 17: Select **HA ports**.

Step 18: In the **Backend pool** list, select **Firewall-Layer-Private**.

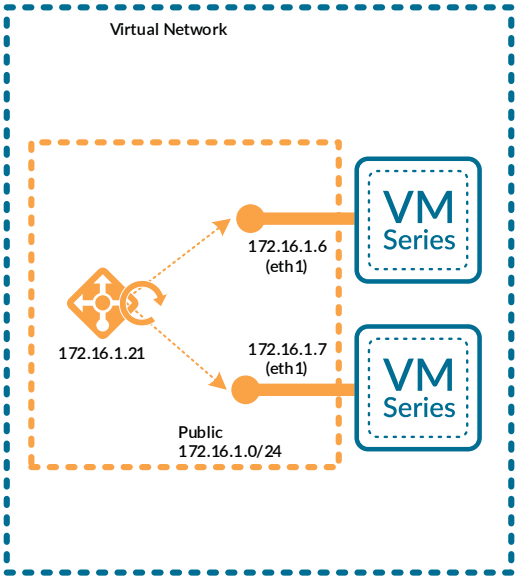
Step 19: In the **Health probe** list, select **HTTPS-Probe**, and then click **OK**.



7.6 Configure the Azure Internal Load-Balancer for Inbound Access

This procedure is required only if you have resources in the Shared-Public subnet that need access to the private networks. Because this subnet uses Azure internal addressing, you cannot use the public load-balancer but instead use an additional frontend IP address and backend pool on the internal load-balancer.

Figure 9 Azure internal load-balancer for inbound access



The frontend IP address is used as the routing next-hop for destination address on the private networks.

Step 1: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Internal**, click **Frontend IP configuration**.

Step 2: Click **Add**.

Step 3: In the **Name** box, enter **Internal-Frontend-Public**.

Step 4: In the **Subnet** list, select **Shared-Public**.

Step 5: In the Assignment section, select **Static**.

Step 6: In the **IP address** box, enter **172.16.1.21**.

Step 7: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Internal**, click **Backend pools**.

Step 8: Click **Add**.

Step 9: In the **Name** box, enter **Firewall-Layer-Public**.

Step 10: In the **Virtual network** list, select **azurerefarch-vnet (X VM)**, where X is the total number of VM-Series firewalls and Panorama virtual machines already deployed in your VNet.

Step 11: In the **VIRTUAL MACHINE** column, select a VM-Series to be added to this backend pool (example: **aras-vmfw1**).

Step 12: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Public** subnet. (example: **ipconfig-untrust**).

Step 13: Repeat Step 11 and Step 12 for all VM-Series firewalls that are to be assigned to this backend pool.

Step 14: Click **Add**.

Step 15: In **Home > Load Balancers > AzureRefArch-Shared-Internal**, click **Load balancing rules**.

Step 16: Click **Add**.

Step 17: In the **Name** box, enter **Public-All-Ports**.

Step 18: In the **Frontend IP address** list, select **Internal-Frontend-Public**.

Step 19: Select **HA ports**.

Step 20: In the **Backend pool** list, select **Firewall-Layer-Public**.

Step 21: In the **Health probe** list, select **HTTPS-Probe**, and then click **OK**.

7.7 Configure Azure User Defined Routes

Azure Networking automatically creates system routes for the address space defined in the VNet. Additional system routes are also added to the Azure route table, including a default route to the internet and null routes for RFC-1918 and RFC-6598 ranges.

Override the Azure system routes with user-defined routes (UDRs) in order to isolate subnets and to logically insert virtual devices such as load-balancers and firewalls into the traffic forwarding path.

Note

Data traffic is not forwarded to the firewalls within the VNet until UDRs are created to direct traffic to the firewalls. In a resilient environment, data traffic is directed to load-balancers that act as frontends for the firewalls contained in their backend pools.

Table 12 Azure system routes

Address space	Address prefix	Next-hop type
VNet defined	192.168.1.0/24	Virtual Network
VNet defined	172.16.0.0/23	Virtual Network
VNet defined	10.5.0.0/16	Virtual Network
Default (Azure defined)	0.0.0.0/0	Internet
RFC-1918 (Azure defined)	10.0.0.0/8	None
RFC-1918 (Azure defined)	172.16.0.0/12	None
RFC-1918 (Azure defined)	192.168.0.0/16	None
RFC-6598 (Azure defined)	100.64.0.0/10	None

If you add a UDR with the same prefix and prefix-length as a system route, the UDR becomes the active route, and the state of the original system route changes to an Invalid state.

If you add a UDR with a more specific prefix that falls within the address space of a system route, the UDR becomes an active route, and the original system route also remains in an Active state.

Caution

The use of UDR summary routes may have unexpected consequences. If you apply a UDR summary to a subnet that falls within the summary but does not have a more specific UDR, traffic within the subnet (host to host) is controlled by the UDR.

As an example, if you applied a UDR for 10.5.0.0/16 with a next-hop of 10.5.0.21 (firewall load-balancer) to the 10.5.1.0/24 subnet, then traffic between host 10.5.1.4 and host 10.5.1.5 is routed through the firewall as intrazone traffic. This effectively causes microsegmentation.

Azure networking does not have a concept of equal cost paths; you cannot add multiple UDRs with same prefix and prefix-length with different next-hops to perform traffic load-balancing. The only method by which you may perform load-balancing is by using UDRs to forward traffic to an Azure load-balancing resource.

The effective routing table after adding UDRs is evaluated using traditional routing rules based on longest match of the destination address.

Figure 10 User-defined routes with shared design model

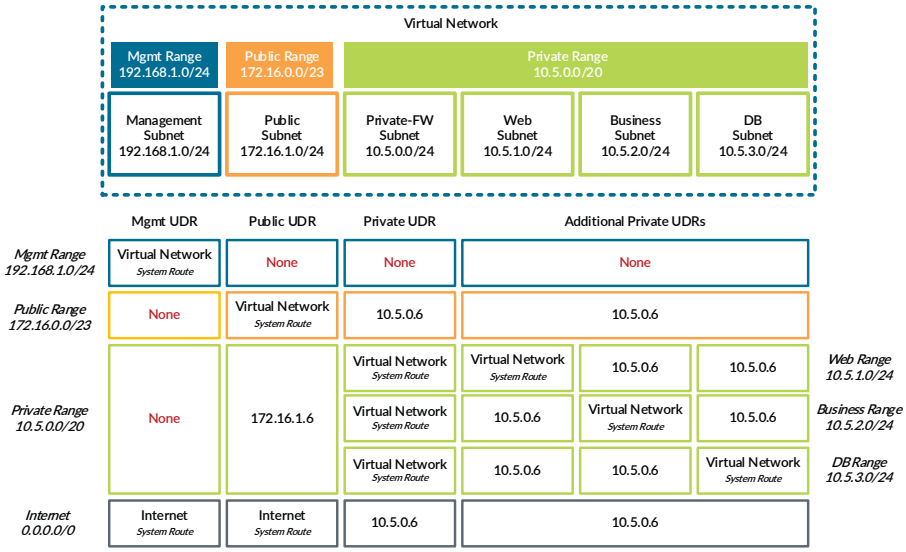


Table 13 Azure route tables

Subnet	Route table name	Resource group	Table of UDRs
Management	AzureRefArch-Management	AzureRefArch	Table 14
Shared-Public	AzureRefArch-Shared-Public	AzureRefArch-Shared	Table 15
Shared-Private	AzureRefArch-Shared-Private	AzureRefArch-Shared	Table 16
Shared-Web	AzureRefArch-Shared-Web	AzureRefArch-Shared	Table 17
Shared-Business	AzureRefArch-Shared-Business	AzureRefArch-Shared	Table 18
Shared-DB	AzureRefArch-Shared-DB	AzureRefArch-Shared	Table 19

Table 14 Management subnet UDRs (192.168.1.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Public	172.16.0.0/23	None	—	Block traffic to Public IP address space
Blackhole-Private	10.5.0.0/20	None	—	Block traffic to Private IP address space

Table 15 Public subnet UDRs (172.16.1.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Net-10.5.0.0	10.5.0.0/20	Virtual Appliance	172.16.1.21	Frontend IP of load-balancer

Table 16 Private subnet UDRs (10.5.0.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Net-172.16.0.0	172.16.0.0/23	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
UDR-default	0.0.0.0/0	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer. Overrides system route

Table 17 Web subnet UDRs (10.5.1.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Net-172.16.0.0	172.16.0.0/23	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
UDR-default	0.0.0.0/0	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer Overrides system route
Net-10.5.2.0 (optional for intrazone)	10.5.2.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
Net-10.5.3.0 (optional for intrazone)	10.5.3.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer

Table 18 Business subnet UDRs (10.5.2.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Net-172.16.0.0	172.16.0.0/23	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
UDR-default	0.0.0.0/0	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer. Overrides system route
Net-10.5.1.0 (optional for intrazone)	10.5.1.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
Net-10.5.3.0 (optional for intrazone)	10.5.3.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer

Table 19 DB subnet UDRs (10.5.3.0/24)

Route name	Address Prefix	Next-hop type	Next-hop address	Comment
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Net-172.16.0.0	172.16.0.0/23	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
UDR-default	0.0.0.0/0	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer. Overrides system route
Net-10.5.1.0 (optional for intrazone)	10.5.1.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer
Net-10.5.2.0 (optional for intrazone)	10.5.2.0/24	Virtual Appliance	10.5.0.21	Frontend IP of load-balancer

Repeat this procedure for each entry in Table 13:

Step 1: In **Home** > **Route** tables, click **Add**.

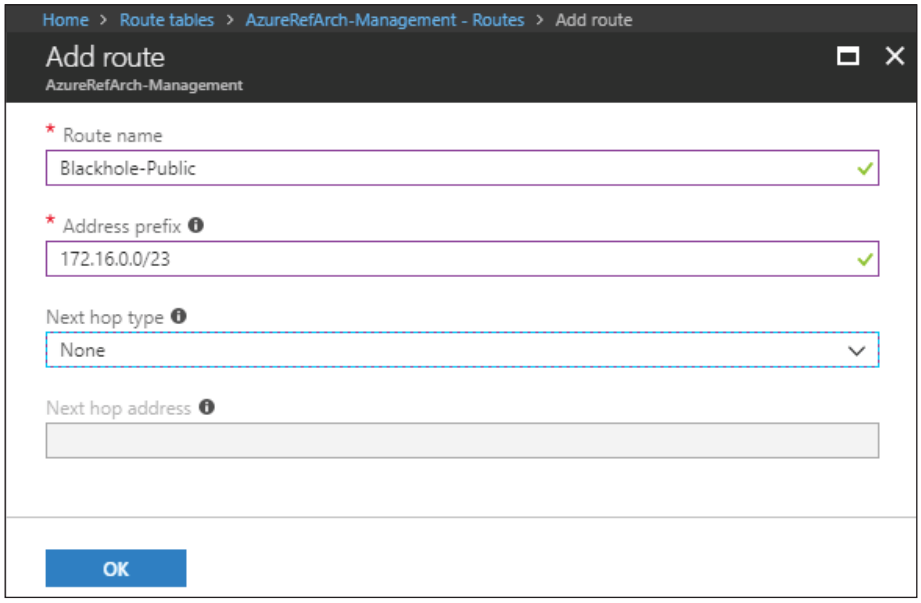
Step 2: In the **Name** box, enter **AzureRefArch-Management**.

Step 3: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**, then click **Create**.

Step 4: In **Home** > **Route tables** > **AzureRefArch-Management**, click **Routes**.

Step 5: Repeat these substeps for all entries in the table of UDRs:

- In **Home** > **Routes tables** > **AzureRefArch-Management—Routes**, click **Add**.
- In the **Route name** box, enter **Blackhole-Public**.
- In the **Address prefix** box, enter **172.16.0.0/23**.
- In the **Next hop type** list, select **None**.
- If the Next-hop type is **Virtual appliance**, then enter the **Next hop address** value and click **OK**.



7.8 Apply Route Tables to Subnets

The UDRs take effect only after the route table is associated with the subnet.

Step 1: In **Home** > **Virtual networks** > **AzureRefArch-VNET**, click **Subnets**.

Step 2: Click **Management**.

Step 3: Click the **Route table** section, and then in the Resource pane, select **AzureRefArch-Management**.

Step 4: Click **Save**, and then click **X** to Close.

Step 5: Repeat Step 2 through Step 4 for each entry in Table 13.

Procedures

Using Panorama to Configure Centralized Security Policy and NAT Policy

This procedure group includes the objects, NAT policy rules, and security policy rules for each of the traffic profiles in the shared design model:

- Inbound access traffic profile
- Outbound access traffic profile
- East/West traffic profile

Each traffic profile is described and configured separately so that you can cover the significant differences in detail and in context.

All procedures and steps in this procedure group are performed on Panorama.

Note

Verify that you have selected the proper device group for the following procedures.

8.1 Create Logging Profile for Logging Service

This procedure creates the log-forwarding profile to send security policy logs to Logging Service. This profile is associated to security policy rules used in each of three traffic profiles. Because the log forwarding profile is referenced in every security policy rule, you must complete this procedure first.

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

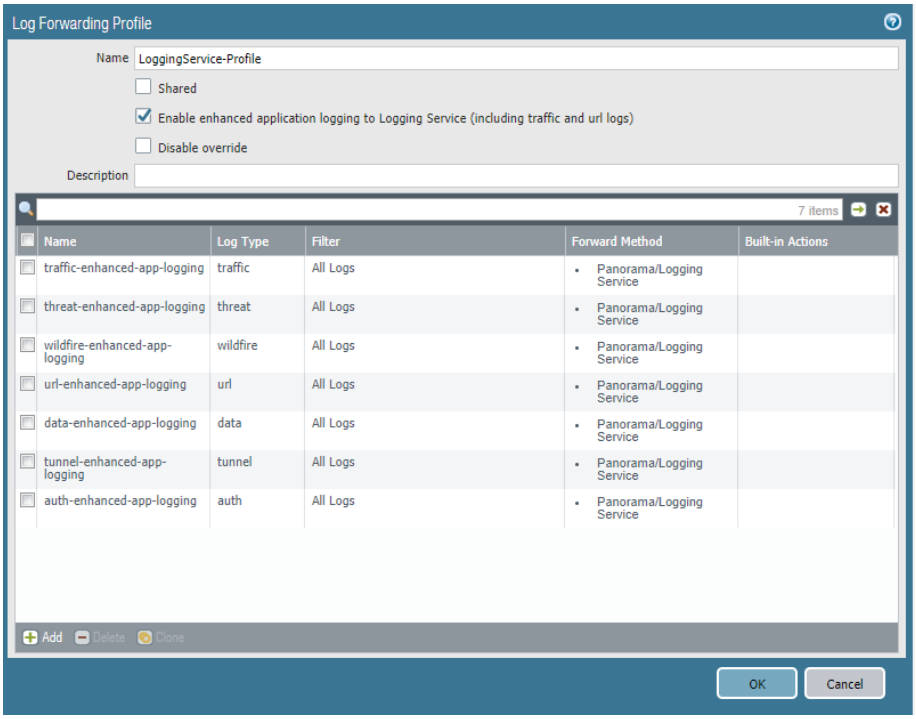
Step 2: Navigate to **Device Groups > Objects**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups > Objects > Log Forwarding**, click **Add**.

Step 5: In the **Name** box, enter **LoggingService-Profile**.

Step 6: Select **Enable enhanced application logging to Logging Service (including traffic and url logs),** and then click **OK**.



8.2 Inbound Access—Create Address Objects

This procedure assumes that you have already deployed a set of web server resources in the Shared-Web subnet. In a resilient web server model, the web servers are in a backend pool of an Azure internal load-balancer. The load-balancer frontend IP is referenced by security and NAT policy rules and should be defined as an address object (example: **10.5.0.20**). This guide does not include the procedure to create this load-balancer or to create the web server resources.

Table 20 Inbound traffic address objects

Object name	Description	Type	Type value
Host-Shared-Public-Web	FQDN of public web server	FQDN	aras-public-shared-web.westus.cloudapp.azure.com
Host-Shared-Private-Web-ILB	IP address of private internal load-balancer	IP Netmask	10.5.0.20

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups > Objects**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

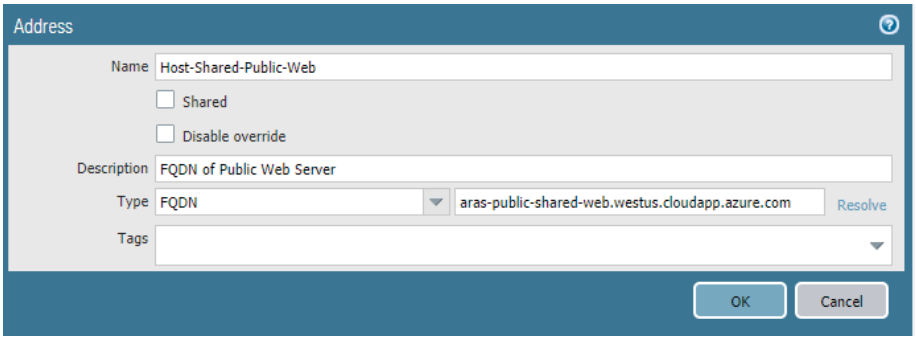
Step 4: In **Device Groups > Objects > Addresses**, click **Add**.

Step 5: In the **Name** box, enter **Host-Shared-Public-Web**.

Step 6: In the **Type** list, select **FQDN**.

Step 7: In the **Type value** box, enter **aras-public-shared-web.westus.cloudapp.azure.com**, and then click **OK**.

Step 8: Repeat Step 4 through Step 7 for all rows in Table 20.



8.3 Inbound Access—Configure NAT Policy

This procedure uses NAT Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device.

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups > Policies**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups > Policies > NAT > Pre Rules**, click **Add**.

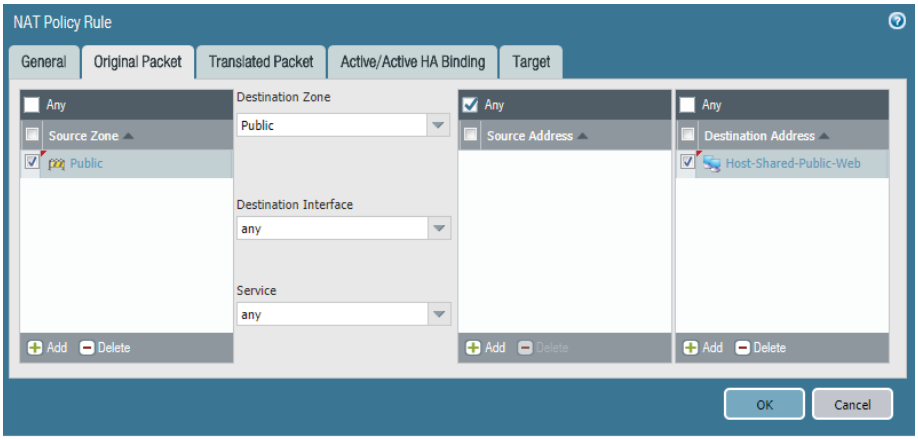
Step 5: In the **Name** box, enter **Inbound-Shared-Web**.

Step 6: Change to the **Original Packet** tab.

Step 7: In the Source Zone pane, click **Add** and select **Public**.

Step 8: In the **Destination Zone** list, select **Public**.

Step 9: In the Destination Address pane, click **Add** and select **Host-Shared-Public-Web**.



Step 10: Change to the **Translated Packet** tab.

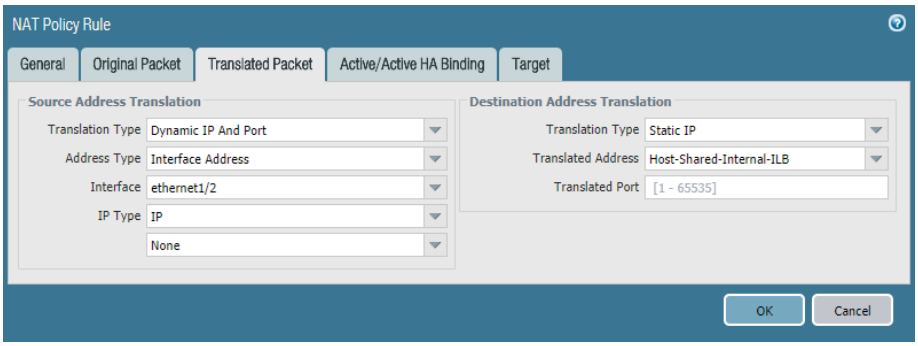
Step 11: In the Source Address Translation section, in the **Translation Type** list, select **Dynamic IP And Port**.

Step 12: In the Source Address Translation section, in the **Address Type** list, select **Interface Address**.

Step 13: In the Source Address Translation section, in the **Interface box**, enter **ethernet1/2**.

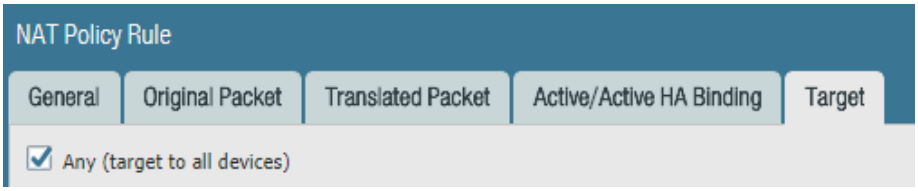
Step 14: In the Destination Address Translation section, in the **Translation Type** list, select **Static IP**.

Step 15: In the Destination Address Translation section, in the **Translated Address** list, select **Host-Shared-Private-Web-ILB**.



Step 16: Change to the **Target** tab.

Step 17: Verify that **Any (target to all devices)** is selected.



Caution

Make sure to target all devices in the device group; otherwise, the policy rule will not be automatically applied to new group members.

8.4 Inbound Access—Configure Security Policy

This procedure uses security Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device.

The security policy example for the Inbound Access Profile permits these applications:

- web-browsing
- SSL (ssl)

Add additional applications to your policy as required.

Step 1: In **Device Groups > Policies > Security > Pre Rules**, click **Add**.

Step 2: In the **Name** box, enter **Inbound-Shared-Web**.

Step 3: Change to the **Source** tab.

Step 4: In the Source Zone pane, click **Add** and select **Public**.

Step 5: Change to the **Destination** tab.

Step 6: In the Destination Zone pane, click **Add** and select **Private**.

Step 7: In the Destination Address pane, click **Add** and select **Host-Shared-Public-Web**.

Step 8: Change to the **Application** tab.

Step 9: In the Applications pane, click **Add** and enter/search/select **web-browsing**.

Step 10: In the Applications pane, click **Add** and enter/search/select **ssl**.

Step 11: Change to the **Service/URL Category** tab.

Step 12: In the Service pane, select **application-default**.

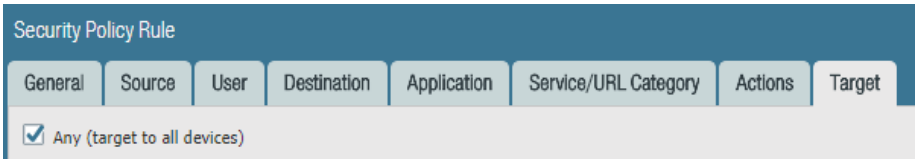
Step 13: Change to the **Actions** tab.

Step 14: In the Action Setting section, in the **Action** list, select **Allow**.

Step 15: In the Log Setting section, in the **Log Forwarding** list, select **LoggingService-Profile**.

Step 16: Change to the **Target** tab.

Step 17: Verify that **Any (target to all devices)** is selected, and then click **OK**.



Caution

Make sure to target all devices (any) in the device group; otherwise, the policy rule will not be automatically applied to new group members.

				Source		Destination							
	Name	Location	Type	Zone	Address	Zone	Address	Application	Service	Action	Profile	Options	Target
1	Inbound-Shared-Web	Azure-Shared	universal	Public	any	Private	Host-Shared-Public-Web	ssl web-browsing	application-default	Allow	none		any

Step 18: On the **Commit** menu, click **Commit and Push**.

8.5 Outbound Access—Create Public IP Address and Associate with Firewall

For virtual machines behind the firewall to communicate to devices on the internet, the firewall must translate the source IP address of the outbound traffic to an IP address on the public subnet. The simplest method is to use dynamic IP and port translation to the firewall's public interface IP address.

Azure then translates the source IP address again as the outbound traffic leaves the VNet. Because the firewall's public interface is a member of the Azure public load-balancer backend pool, Azure networking performs translation for only TCP/UDP ports referenced in the active load balancing rules. To support a broad range of services, create a new public IP address for the public interface of each firewall used for outbound access. This method supports all TCP/UDP ports.

Step 1: In **Home > Public IP addresses**, click **Add.**

Step 2: In the **Name** box, enter **aras-vmfw1-outbound**.

Step 3: Select **Standard** SKU.

Step 4: In the **DNS name label** box, enter **aras-vmfw1-outbound**.

Step 5: In the Resource Group section, choose **Use Existing**, and then select **AzureRefArch-Shared**.

Step 6: Click **Create**.

Step 7: After the address has been successfully created, in **Home > Public IP address > aras-vmfw1-outbound**, click **Associate**.

Step 8: In the Associate Public IP address pane, in the **Resource type** list, select **Network interface**.

Step 9: In the Choose Network Interface pane, select the public interface of **aras-vmfw1** (example: **aras-vmfw1-eth1**), and then click **OK**.

Step 10: Repeat this procedure for any additional firewalls used for outbound access.

8.6 Outbound Access—Create Address Objects

Network objects are created to simplify the creation of NAT and security policy rules.

Table 21 Outbound traffic address objects

Object name	Description	Type	Type value
Net-10.5.1.0	Web subnet	IP Netmask	10.5.1.0/24
Net-10.5.2.0	Business subnet	IP Netmask	10.5.2.0/24
Net-10.5.3.0	DB subnet	IP Netmask	10.5.3.0/24

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups** > **Objects**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups** > **Objects** > **Addresses**, click **Add**.

Step 5: In the **Name** box, enter **Net-10.5.1.0**.

Step 6: In the **Type** list, select **IP Netmask**.

Step 7: In the **Type value** box, enter **10.5.1.0/24**, and then click **OK**.

Step 8: Repeat Step 4 through Step 7 for all rows in Table 21.

8.7 Outbound Access—Configure NAT Policy

This procedure uses NAT Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device.

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups** > **Policies**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups** > **Policies** > **NAT** > **Pre Rules**, click **Add**.

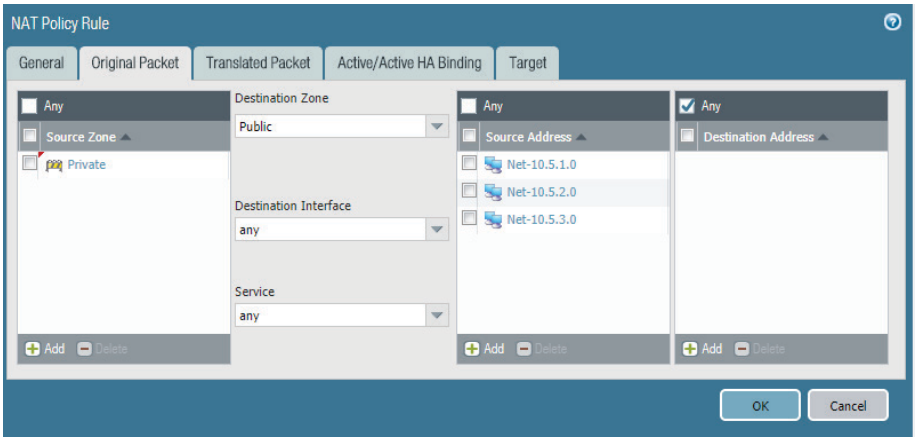
Step 5: In the **Name** box, enter **Outbound-Internet**.

Step 6: Change to the **Original Packet** tab.

Step 7: In the Source Zone pane, click **Add** and select **Private**.

Step 8: In the **Destination Zone** list, select **Public**.

Step 9: In the Source Address pane, click **Add** and select **Net-10.5.1.0**. Repeat this step for all objects in Table 21.

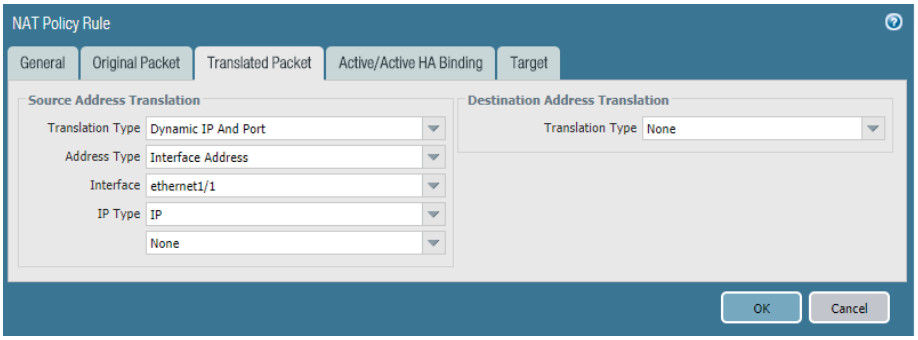


Step 10: Change to the **Translated Packet** tab.

Step 11: In the Source Address Translation section, in the **Translation Type** list, select **Dynamic IP And Port**.

Step 12: In the Source Address Translation section, in the **Address Type** list, select **Interface Address**.

Step 13: In the Source Address Translation section, in the **Interface box**, enter **ethernet1/1**.



Step 14: Change to the **Target** tab.

Step 15: Verify that **Any (target to all devices)** is selected.

> **Caution**
>
> Make sure to target all devices in the device group. Otherwise, the policy rule will not be automatically applied to new group members.

8.8 Outbound Access—Configure Security Policy

This procedure uses security Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device. This example uses a common outbound policy for all private subnets. If you wish to use a differentiated policy, create separate rules for each subnet.

The security policy example for the Outbound Access Profile permits these applications:

- web-browsing
- SSL (ssl)
- google-base

Add additional applications to your policy as required.

Step 1: In **Device Groups > Policies > Security > Pre Rules**, click **Add**.

Step 2: In the **Name** box, enter **Outbound-Internet**.

Step 3: Change to the **Source** tab.

Step 4: In the Source Zone pane, click **Add** and select **Private**.

Step 5: In the Source Address pane, click **Add** and select **Net-10.5.1.0**. Repeat this step for all objects in Table 21

Step 6: Change to the **Destination** tab.

Step 7: In the Destination Zone pane, click **Add** and select **Public**.

Step 8: Change to the **Application** tab.

Step 9: In the Applications pane, click **Add** and enter/search/select **web-browsing**.

Step 10: In the Applications pane, click **Add** and enter/search/select **ssl**.

Step 11: In the Applications pane, click **Add** and enter/search/select **google-base**.

Step 12: Change to the **Service/URL Category** tab.

Step 13: In the **Service** pane, select **application-default**.

Step 14: Change to the **Actions** tab.

Step 15: In the Action Setting section, in the **Action** list, select **Allow**.

Step 16: In the Log Setting section, in the **Log Forwarding** list, select **LoggingService-Profile**.

Step 17: Change to the **Target** tab.

Step 18: Verify that **Any (target to all devices)** is selected, and then click **OK**.

				Source		Destination							
	Name	Location	Type	Zone	Address	Zone	Address	Application	Service	Action	Profile	Options	Target
2	Outbound-Internet	Azure-Shared	universal	Private	Net-10.5.1.0 Net-10.5.2.0 Net-10.5.3.0	Public	any	google-base ssl web-browsing	application-default	Allow			any

Caution

Make sure to target all devices (any) in the device group; otherwise, the policy rule will not be automatically applied to new group members.

Step 19: On the **Commit** menu, click **Commit and Push**.

8.9 East/West Traffic

Traffic that originates from a virtual machine within a private subnet—and is destined to a virtual machine in different private subnet—routes to the firewall through a user-defined route table applied to the virtual machine's subnet. Virtual machines that can communicate to each other without the need for a firewall to protect the traffic can be on the same subnet, and virtual machines that do need traffic protection should be on different subnets.

Because the traffic flow for the East/West Traffic Profile always stays within the Private zone, the firewall security policy uses a Rule Type of **intrazone**.

Because both ends of the communication are within the VNet, the firewall should not apply a NAT policy to traffic between private subnets.

Note

Azure networking does not require the use of source NAT on the firewall to enforce symmetry if both directions of the flow pass through the same Azure internal load-balancer. The private subnets have UDRs directing East/West traffic to the firewall layer, so NAT is not required.

This procedure reuses objects already created in Procedure 8.6. If necessary, create additional objects using the same procedure.

This procedure uses security Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device. The example policy assumes three subnets with a granular policy with each as a source to the other two destinations.

Table 22 East/West security policy rules (example)

Source	Destination	Rule
Net-10.5.1.0 (web)	Net-10.5.2.0 (business)	Web-to-Business
Net-10.5.1.0 (web)	Net-10.5.3.0 (DB)	Web-to-DB
Net-10.5.2.0 (business)	Net-10.5.1.0 (web)	Business-to-Web
Net-10.5.2.0 (business)	Net-10.5.3.0 (DB)	Business-to-DB
Net-10.5.3.0 (DB)	Net-10.5.1.0 (web)	DB-to-Web
Net-10.5.3.0 (DB)	Net-10.5.2.0 (business)	DB-Business

The example security policy for the East/West Access Profile permits these applications:

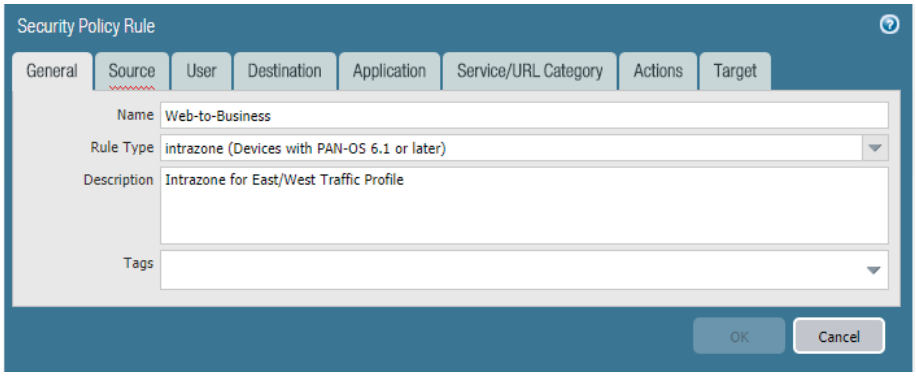
- SSH (ssh)
- RDP (ms-rdp)

Add additional required applications to your policy as needed.

Step 1: In **Device Groups** > **Policies** > **Security** > **Pre Rules**, click **Add**.

Step 2: In the **Name** box, enter **Web-to-Business**.

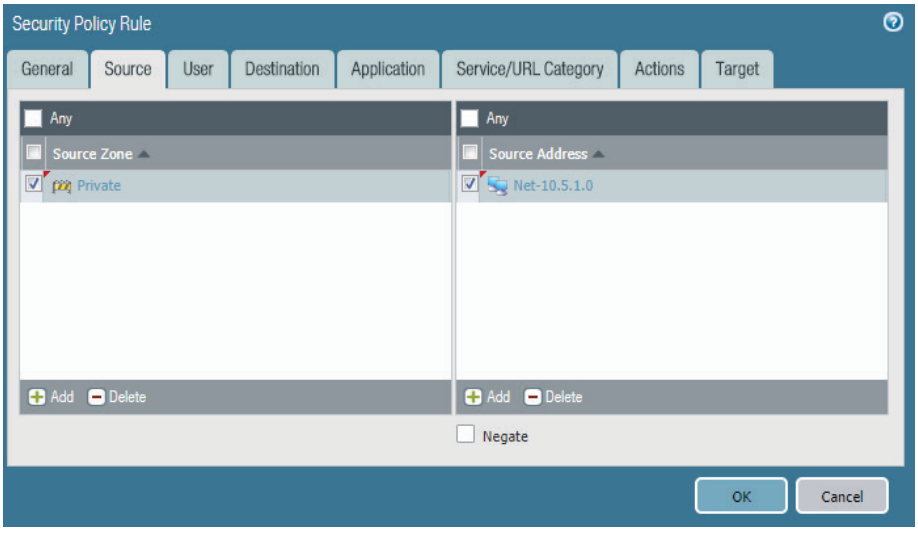
Step 3: In the **Rule Type** list, select **intrazone**.



Step 4: Change to the **Source** tab.

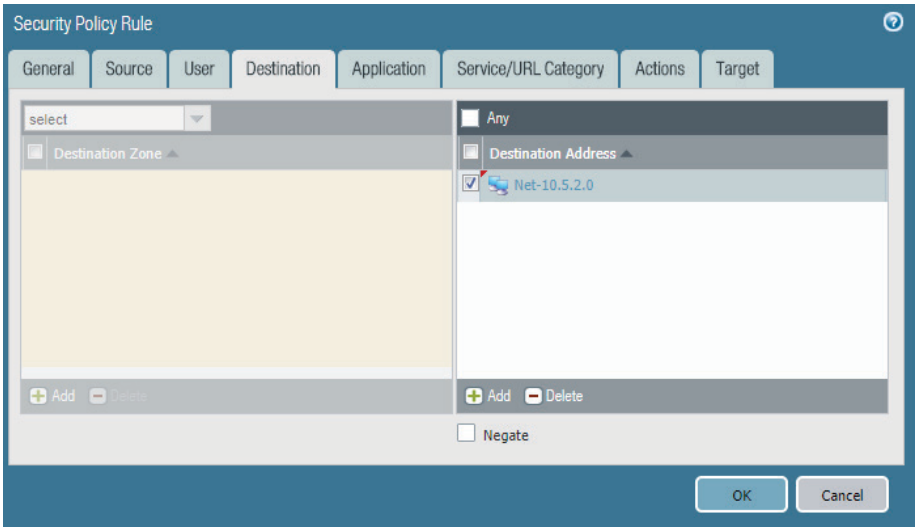
Step 5: In the Source Zone pane, click **Add** and select **Private**.

Step 6: In the Source Address pane, click **Add** and select **Net-10.5.1.0**.



Step 7: Change to the **Destination** tab.

Step 8: In the Destination Address pane, click **Add** and select **Net-10.5.2.0**.



Step 9: Change to the **Application** tab.

Step 10: In the Applications pane, click **Add** and enter/search/select **ssh**.

Step 11: In the Applications pane, click **Add** and enter/search/select **ms-rdp**.

Step 12: Change to the **Service/URL Category** tab.

Step 13: In the Service pane, select **application-default**.

Step 14: Change to the **Actions** tab.

Step 15: In the Action Setting section, in the **Action** list, select **Allow**.

Step 16: In the Log Setting section, in the **Log Forwarding** list, select **LoggingService-Profile**.

Step 17: Change to the **Target** tab.

Step 18: Verify that **Any (target to all devices)** is selected, and then click **OK**.

	Name	Location	Type	Source		Destination		Application	Service	Action	Profile	Options	Target
				Zone	Address	Zone	Address						
13	Web-to-Business	Azure-Shared	intrazone	Private	Net-10.5.1.0	(intrazone)	Net-10.5.2.0	ms-rdp ssh	application-default	Allow	none		any

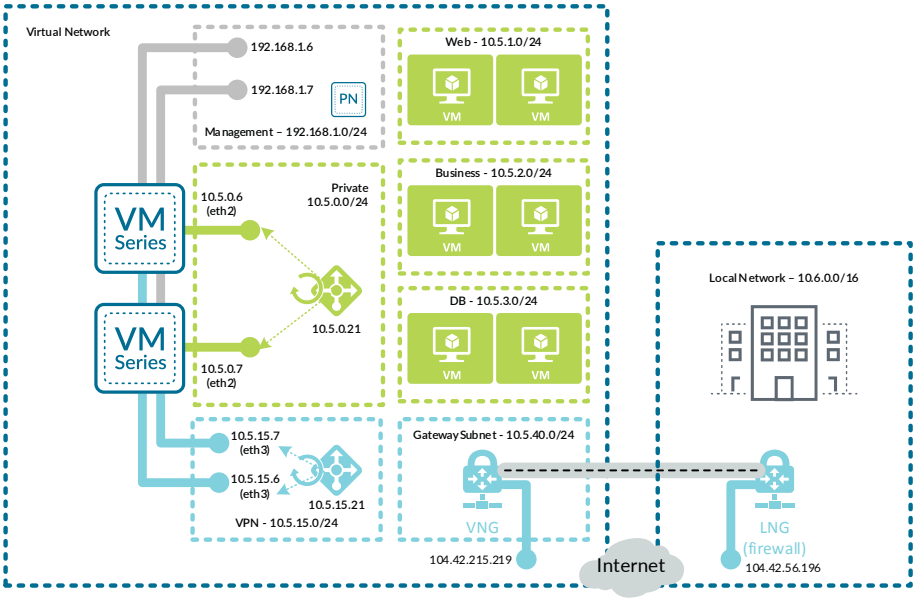
> **Caution**
>
> Make sure to target all devices (any) in the device group; otherwise, the policy rule will not be automatically applied to new group members.

Step 19: On the **Commit** menu, click **Commit and Push**.

Deployment Details for Backhaul Connection

Use the following procedure groups to build an IPSec VPN connection for backhaul between Azure and your on-site network over the internet. The VPN endpoints used are the Azure Virtual Network Gateway (VNG) and an on-site Local Network Gateway (LNG). The LNG used in this guide is a Palo Alto Networks next-generation firewall.

Figure 11 Backhaul connection to on-site network



Note

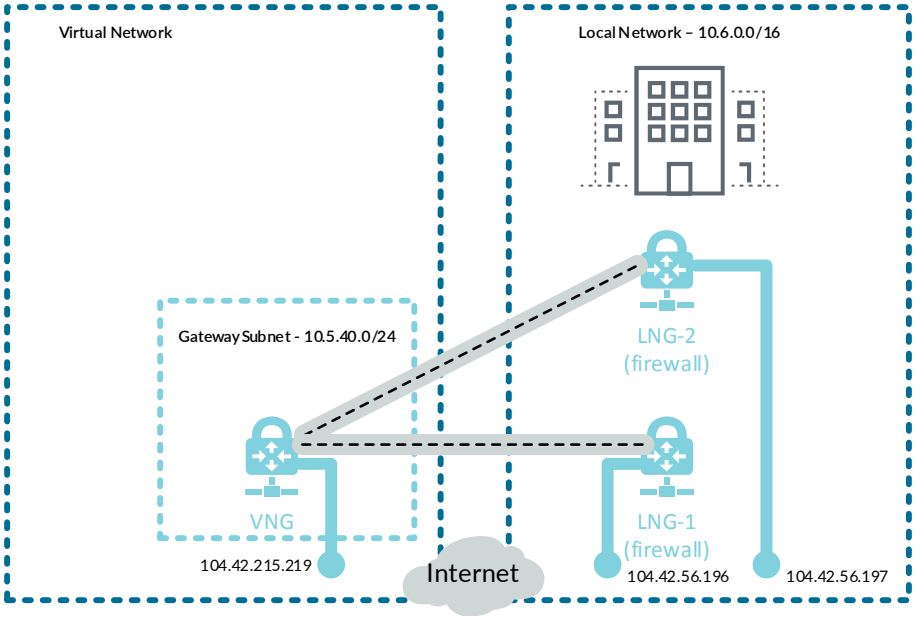
The connection from Azure to the on-site network was tested and validated only with a specific design and includes two options: static routing and BGP routing. Other variants to the backhaul design may work with similar configurations but have not been explicitly tested.

A resilient design for the backhaul uses a pair of connections from Azure to the on-site network and must use BGP routing. An additional LNG is deployed on-site to terminate the second connection from the Azure VNG. Routing will be configured to prefer the first connection as active and the second connection as standby to ensure that traffic is routed symmetrically between the on-site network and Azure.

Note

Every Azure VPN gateway consists of two instances in an active-standby configuration. For any planned maintenance or unplanned disruption that happens to the active instance, the standby instance would take over automatically and resume the VPN connections.

Figure 12 Resilient backhaul connection



Procedures

Configuring Azure Networking for Backhaul Connection

9.1 Configure the Azure Internal Load-Balancer for Backhaul

9.2 Configure Azure User Defined Routes

9.3 Apply Route Tables to Subnets

9.4 Modify Existing Route Tables

9.5 Create the VPN Gateway Subnet.

9.6 Create Public IP for VPN Gateway

9.7 Deploy Virtual Network Gateway on Azure

9.8 Create Local Network Gateway

9.9 Create VPN Connection from VNG to LNG

This procedure group relies on the following assumptions:

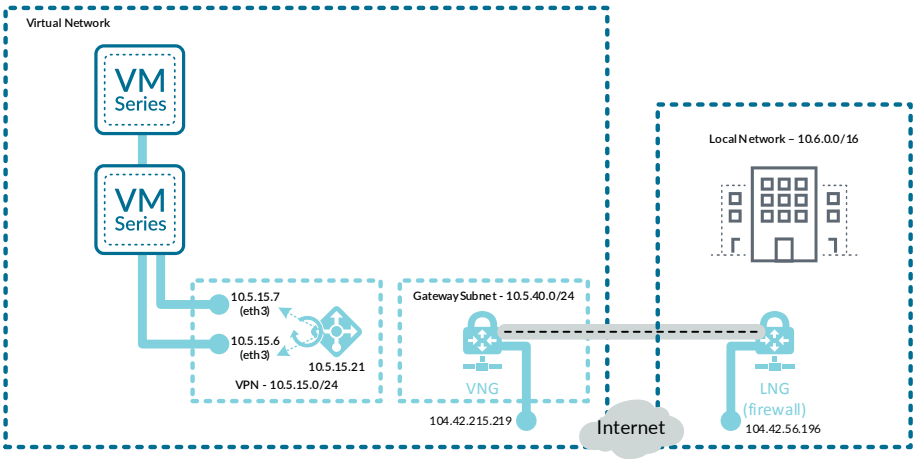
- The on-site local network IP address block is **10.6.0.0/16**.
- The existing on-site firewall must have a statically assigned public IP address.
- The Azure subnet reachable for Panorama and VM-Series management is **192.168.1.0/24**.
- The Azure subnets reachable for in-band access (Web, DB, Business) included within the IP address range are **10.5.0.0/20**.

Use the Azure Resource Manager to complete the following procedures. Sign in to Azure at https://portal.azure.com.

9.1 Configure the Azure Internal Load-Balancer for Backhaul

Because the VPN gateway subnet uses Azure internal addressing, you use an additional frontend IP address and back-end pool on the internal load-balancer.

Figure 13 Azure internal load-balancer for backhaul



The frontend IP address is used as the routing next-hop for destination addresses on the private networks.

Step 1: In **Home > Load Balancers > AzureRefArch-Shared-Internal**, click **Frontend IP configuration**.

Step 2: Click **Add**.

Step 3: In the **Name** box, enter **Internal-Frontend-VPN**.

Step 4: In the **Subnet** list, select **Shared-VPN**.

Step 5: In the Assignment section, select **Static**.

Step 6: In the **IP address** box, enter **10.5.15.21**.

Step 7: In **Home > Load Balancers >** **AzureRefArch-Shared-Internal**, click **Backend pools**.

Step 8: Click **Add**.

Step 9: In the **Name** box, enter **Firewall-Layer-VPN**.

Step 10: In the **Virtual network** list, select **azurerefarch-vnet (X VM)**, where X is the total number of VM-Series firewalls and Panorama virtual machines already deployed in your VNet.

Step 11: In the **VIRTUAL MACHINE** column, select a VM-Series to be added to this backend pool (example: **aras-vmfw1**).

Step 12: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Public** subnet. (example: **ipconfig-dmz**).

Step 13: Repeat Step 11 and Step 12 for all VM-Series firewalls that are to be assigned to this backend pool.

Step 14: Click **Add**.

Step 15: In **Home > Load Balancers >** **AzureRefArch-Shared-Internal**, click **Load balancing rules**.

Step 16: Click **Add**.

Step 17: In the **Name** box, enter **VPN-All-Ports**.

Step 18: In the **Frontend IP address** list, select **Internal-Frontend-VPN**.

Step 19: Select **HA ports**.

Step 20: In the **Backend pool** list, select **Firewall-Layer-VPN**.

Step 21: In the **Health probe** list, select **HTTPS-Probe**, and then click **OK**.

9.2 Configure Azure User Defined Routes

This procedure relies on the following assumptions:

- The on-site local network IP address block is **10.6.0.0/16**.
- The existing on-site firewall BGP peer address (assigned to tunnel interface) is **10.6.2.255**.
- The existing on-site firewall must have a statically assigned public IP address.
- The Azure subnet reachable for Panorama and VM-Series management is **192.168.1.0/24**.
- The Azure subnets reachable for in-band access (Web, DB, Business) included within the IP address range are **10.5.0.0/20**.

Table 23 Azure route tables

Subnet	Route table name	Resource group	Table of UDRs
Shared-VPN	AzureRefArch-Shared-VPN	AzureRefArch-Shared	Table 24
GatewaySubnet	AzureRefArch-VPNGateway	AzureRefArch	Table 25

Table 24 VPN subnet UDRs (10.5.15.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Management	192.168.1.0/24	None	—	Block traffic to Management IP address space
Blackhole-Public	172.16.0.0/23	None	—	Block traffic to Public IP address space

Table 25 VPN gateway subnet UDRs (10.5.40.0/24)

Route name	Address prefix	Next-hop type	Next-hop address	Comments
Blackhole-Public	172.16.0.0/23	None	—	Block traffic to Public IP address space
Net-10.5.0.0	10.5.0.0/20	Virtual Appliance	10.5.15.21	Frontend IP of load-balancer

Repeat this procedure for each entry in Table 23:

Step 1: In **Home** > **Route** tables, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-Shared-VPN**.

Step 3: In the Resource Group section, choose **Use Existing,** select **AzureRefArch-Shared**, and then click **Create**.

Step 4: In **Home** > **Route tables** > **AzureRefArch-Shared-VPN**, click **Routes**.

Step 5: Repeat these substeps for all entries in the table of UDRs:

- In **Home** > **Routes tables** > **AzureRefArch-VPN—Routes**, click **Add**.
- In the **Route name** box, enter **Blackhole-Public**.
- In the **Address prefix** box, enter **172.16.0.0/23**.
- In the **Next hop type** list, select **None**.
- If the Next-hop type is Virtual appliance, then enter the Next-hop address value and click **OK**.

9.3 Apply Route Tables to Subnets

The UDRs only take effect after the route table is associated with the subnet.

Step 1: In **Home** > **Virtual networks** > **AzureRefArch-VNET**, click **Subnets**.

Step 2: Click **Shared-VPN**.

Step 3: Click the **Route table** section, and in the Resource pane, select **AzureRefArch-Shared-VPN**.

Step 4: Click **Save**, and then click **X** to Close.

9.4 Modify Existing Route Tables

Azure networking routes traffic from all subnets to the on-site network range directly to the VNG by default. This design allows implicit access for the Management subnet to support in-band management of Panorama and the VM-Series.

To block the traffic or enforce a firewall policy requires that you create UDRs. Configure the UDRs to explicitly blocked traffic to the on-site network from the public subnet. Configure the UDRs to redirect traffic from all other subnets to the firewall layer for policy enforcement.

The route tables in Table 26 were originally created in Procedure 7.7. Modify the route tables listed in Table 26 by adding the additional specified routes. If you have additional on-site prefixes, then each prefix requires a UDR in each routing table.

Caution

When adding additional on-site networks, you must manually update the route tables to block and redirect to the new prefixes as they are added. This step is required even when running dynamic BGP routing.

Table 26 Route table modifications for backhaul

Route table name	Route name	Address prefix	Next-hop type	Next-hop address	Comments
AzureRefArch-Shared-Public	Blackhole-OnSite	10.6.0.0/16	None	—	Block traffic to On-site IP address space
AzureRefArch-Shared-Private	Net-10.6.0.0	10.6.0.0/16	Virtual appliance	10.5.0.21	Frontend IP of load-balancer Access to on-site network through the firewall layer
AzureRefArch-Shared-Web	Net-10.6.0.0	10.6.0.0/16	Virtual appliance	10.5.0.21	Frontend IP of load-balancer Access to on-site network through the firewall layer
AzureRefArch-Shared-Business	Net-10.6.0.0	10.6.0.0/16	Virtual appliance	10.5.0.21	Frontend IP of load-balancer Access to on-site network through the firewall layer
AzureRefArch-Shared-DB	Net-10.6.0.0	10.6.0.0/16	Virtual appliance	10.5.0.21	Frontend IP of load-balancer Access to on-site network through the firewall layer

9.5 Create the VPN Gateway Subnet.

This procedure adds a new subnet for the VPN Gateway to the existing VNet.

Step 1: In **Home > Virtual networks > AzureRefArch-VNET**, click **Subnets.**

Step 2: Click **Gateway subnet** to add a new gateway subnet.

Step 3: In the **Address Range (CIDR block)** box, enter **10.5.40.0/24**.

Step 4: Click the **Route table** section, select **AzureRefArch-VPNGateway**, and then click **OK**.

9.6 Create Public IP for VPN Gateway

Step 1: In **Home > Public IP addresses**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-VNG-Public**.

Step 3: Select **Basic** SKU.

> **Note**
>
> Do not choose a Standard IP SKU for the public IP address of your Virtual Network Gateway. The Standard IP SKU uses only static IP address assignment. Azure Resource Manager does not permit this selection and presents the following error: "Static public IP address can only be assigned to load-balancers."

Step 4: In the IP address assignment section, select **Dynamic**.

> **Note**
>
> In the **DNS name label** box, do not enter a value. Azure does not support dynamic resolution of the FQDN for a VPN gateway.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 6: Click **Create**.

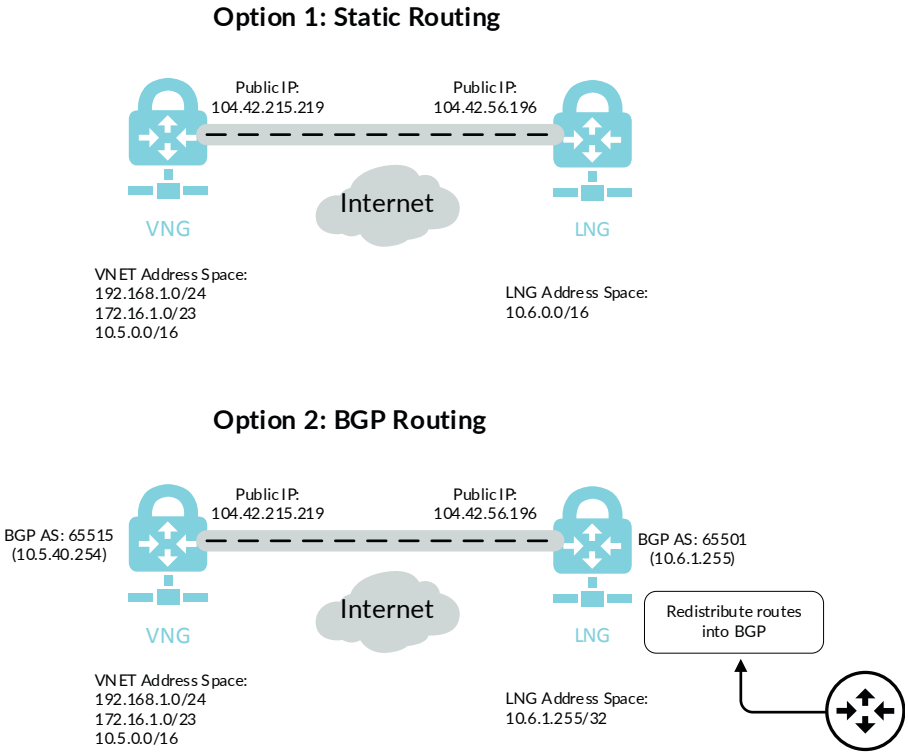
The on-premise firewall requires a peer IP address for the Azure VNG. The actual IP address is not assigned by Azure until the VNG is created and the public IP address is associated.

9.7 Deploy Virtual Network Gateway on Azure

This procedure includes two routing options, static routing and dynamic routing with BGP. The static routing option is simpler to configure but requires manual modification for any routing changes. The BGP option is more complex to initially configure but is easier to operate and maintain in a rapidly changing environment.

Refer to Figure 14 for this and the following procedures.

Figure 14 Backhaul routing options—static and BGP



Step 1: In **Home > Virtual networks gateways**, click **Add.**

Step 2: In the **Name** box, enter **AzureRefArch-VNG.**

Step 3: In the Gateway type section, select **VPN**.

Step 4: In the VPN type section, select **Route-based**.

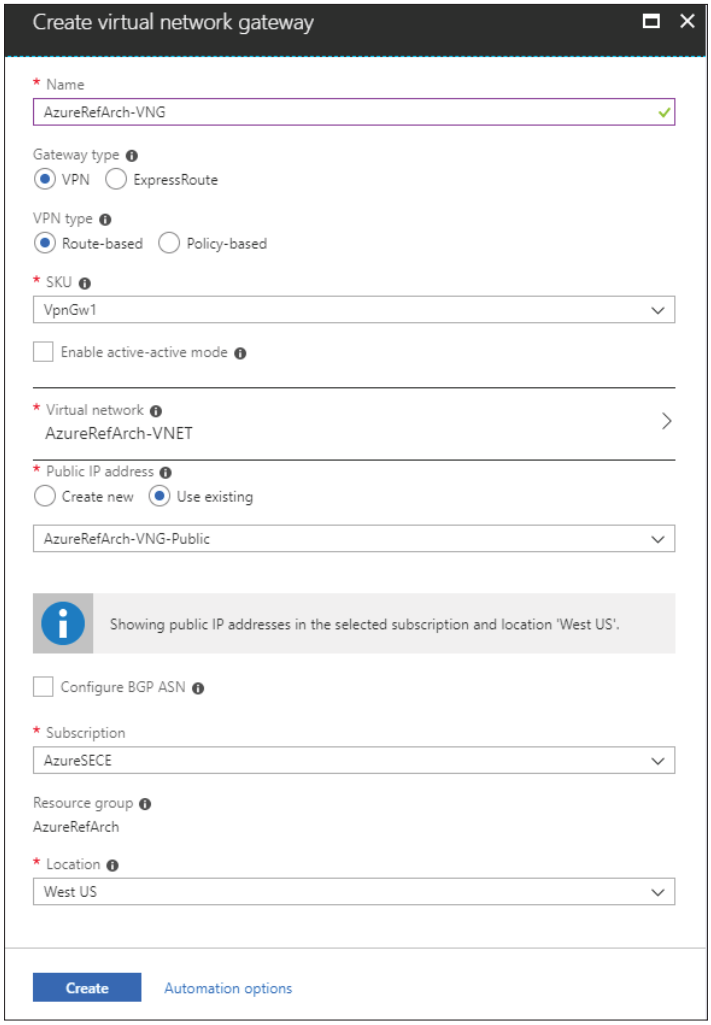
Step 5: In the **SKU** list, select **VpnGw1**. The basic SKU does not support BGP or IKEv2.

Step 6: Click the **Virtual Network** section, and then select **AzureRefArch-VNET**.

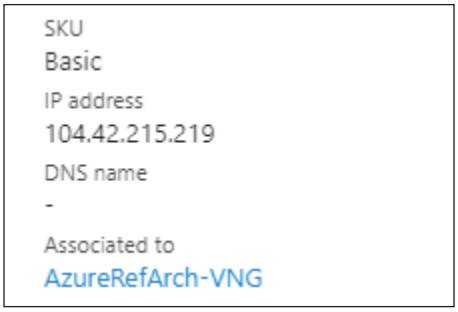
Step 7: Click the **Public IP address** section, select **Use existing**, and then select **AzureRefArch-VNG-Public**.

Step 8: If you're configuring dynamic routing with BGP, select **Configure BGP ASN**, and then in the **Autonomous system number (ASN)** box, accept the proposed default value of **65515**.

Step 9: Click **Create**.

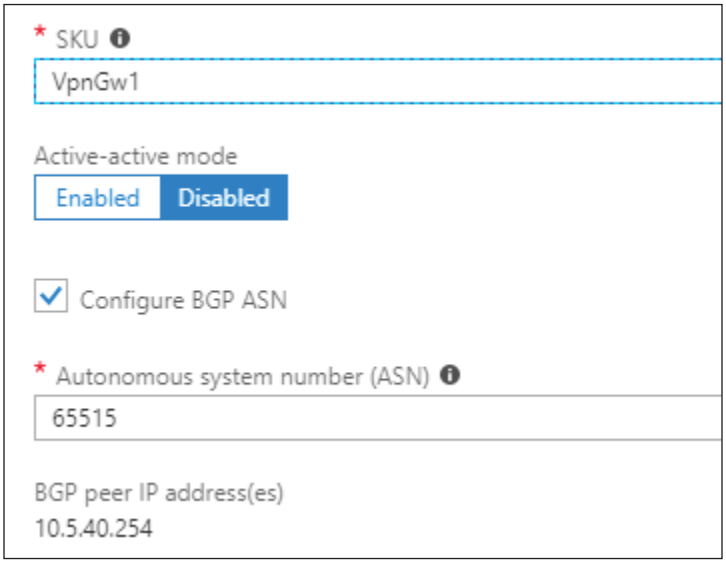


Step 10: In **Home > Public IP addresses > AzureRefArch-VNG-Public**, record the IP address (Example: **104.42.215.219**).



Step 11: If you configured BGP, then in **Home > Virtual network gateways > AzureRefArch-VNG**, click **Configuration**.

Step 12: Record the **BGP peer IP address** assigned to the virtual network gateway (Example: **10.5.40.254**).



9.8 Create Local Network Gateway

The local network gateway corresponds to the on-premise firewall that terminates the IPSec VPN tunnel from Azure.

Step 1: In **Home > Local network gateways**, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-LNG-OnPrem**.

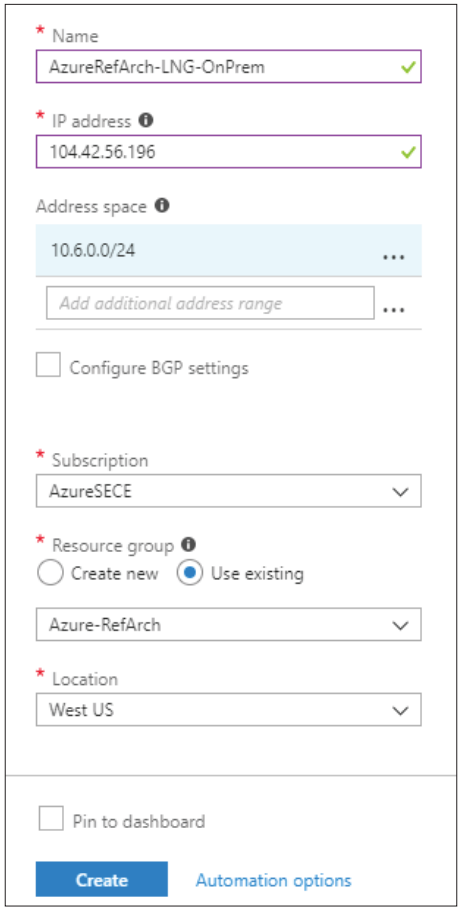
Step 3: In the **IP address** box, enter the public IP address of the on-premise IPSec VPN peer (Example: **104.42.56.196**).

Option 1: Static Routing

Step 1: In the **Address space** box, enter the IP prefix that is reachable through the VPN tunnel. (Example: **10.6.0.0/16**). If multiple IP prefixes are reachable, you must add the additional prefixes by repeating this step multiple times.

Step 2: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 3: Click **Create**.



Option 2: Dynamic Routing with BGP

Step 1: In the **Address space** box, enter only the IP prefix for the BGP peer address from the on-premise firewall this LNG corresponds to. (Example: **10.6.1.255/32**)

Step 2: Select **Configure BGP settings**.

Step 3: In the **Autonomous system number (ASN)** box, enter **65501**.

Step 4: In the **BGP peer IP address** box, enter **10.6.1.255**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 6: Click **Create**.

9.9 Create VPN Connection from VNG to LNG

Step 1: In **Home > Connections**, click **Add**.

Step 2: In **Home > Connections > Create connection > Basics**, in the **Connection type** list, select **Site-to-site (IPsec)**.

Step 3: In the Resource Group section, choose **Use Existing,** select **AzureRefArch**, and then click **OK**.

Step 4: In **Home > Connections > Create connection > Settings,** click the **Virtual network gateway** section, and then select **AzureRefArch-VNG**.

Step 5: Click the **Local network gateway** section, and then select **AzureRefArch-LNG-OnPrem**.

Step 6: In the **Connection name** box, enter **AzureRefarch-to-OnPrem**.

Step 7: In the **Shared key (PSK)** box, enter the value for the pre-shared key (complex password).

Step 8: If you configured BGP, select **Enable BGP**.

Step 9: Click **OK**.

Step 10: Review the Summary and if acceptable, click **OK**.

Procedures

Configuring On-site Firewall for VPN Access to Azure

10.1 Configure Objects and Interfaces

10.2 Configure IKEv2 and IPSec

10.3 Configure Routing

10.4 Configure BGP

These procedures assume the on-site firewall is configured and running with a public interface reachable from the internet and a private interface with access to internal subnets. The firewall is already configured with a default virtual router. DNS and NTP are configured.

The following procedures are completed on the on-site next-generation firewall or VM-Series device. If you are using a second resilient on-site firewall, this procedure group is repeated.

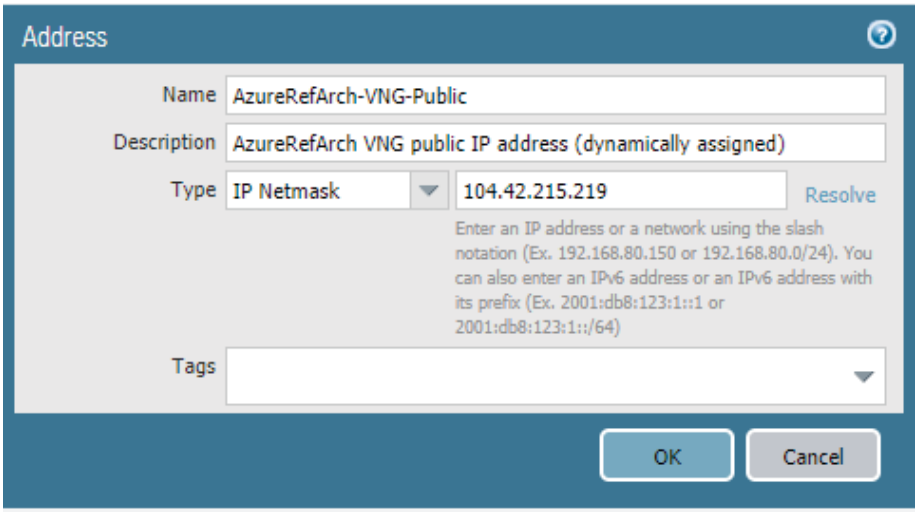
10.1 Configure Objects and Interfaces

Step 1: In **Objects** > **Addresses**, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-VNG-Public**.

Step 3: In the **Type** list, select **IP Netmask**.

Step 4: In the **Type value** box, enter the public IP address that was assigned by Azure (Example: 104.42.215.219), and then click **OK**.



Step 5: In **Network** > **Zones**, click **Add**. The Zone configuration window appears.

Step 6: In the **Name** box, enter **VPN**.

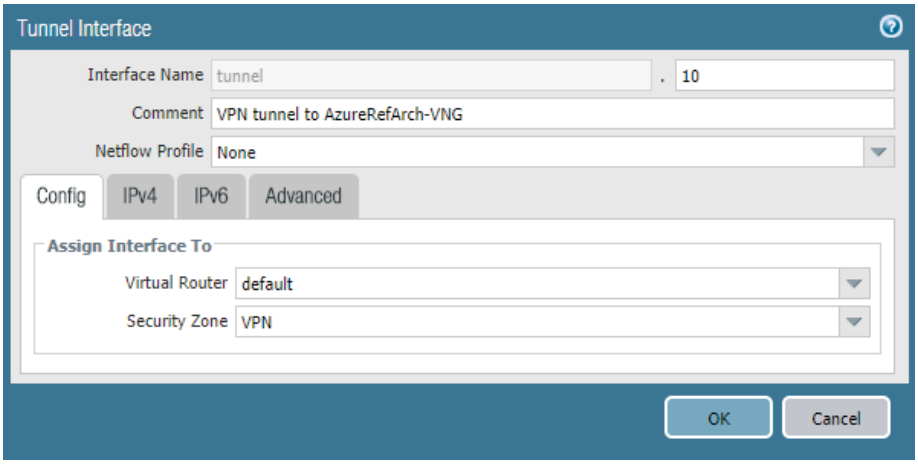
Step 7: In the **Type** list, select **Layer3**, and then click **OK**.

Step 8: In **Network** > **Interfaces**, change to the **Tunnel** tab, and then click **Add**. The Tunnel Interface configuration window appears.

Step 9: In the **Interface Name.subinterface** box, enter **10**.

Step 10: In the **Virtual Router** list, select **default**.

Step 11: In the **Security Zone** list, select **VPN**.



Note

If you are configuring the second device for resilient backhaul, use the value of **10.6.1.254/32** in Step 12.

Step 12: If you configured BGP, change to the **IPv4** tab. In the IP pane, click **Add**, enter **10.6.1.255/32**, and then click **OK**.

Step 13: Change to the **Advanced** tab.

Step 14: In the **MTU** box, enter **1424**, and then click **OK**.

This value is used to minimize IP packet fragmentation due to the tunnel and IPSec encapsulation overhead.

Step 15: In **Network Interfaces**, click the public-facing Ethernet interface (example: **ethernet1/1**).

Step 16: Change to the **Advanced** tab.

Step 17: In the Other Info section, select **Adjust TCP MSS**, and then click **OK**.

This feature is enabled to minimize IP packet fragmentation due to the tunnel and IPSec encapsulation overhead.

10.2 Configure IKEv2 and IPSec

Use the values specified in Table 27 for the steps in this procedure. The firewall can successfully negotiate these values with the Azure VNG without requiring any modification of the Azure default settings. The strongest authentication and encryption values that are compatible with Azure are listed.

Table 27 IKEv2 and IPSec parameters

Parameter	Value	Description
IKEv2 DH group	group2	Diffie-Helman Group 2
IKEv2 authentication	sha256	Secure Hash Algorithm 2 (SHA-2) with 256-bit digest
IKEv2 encryption	aes-256-cbc	Advanced Encryption Standard (AES) Cipher Block Chaining (CBC) with 256-bit key
IKEv2 key lifetime timer	28800 Seconds	—
IKEv2 timer authentication multiple	3	—
IPSec encryption	aes-256-gcm	AES Galois Counter Mode (GCM) with 256-bit key
IPSec authentication	sha512	Secure Hash Algorithm 2 (SHA-2) with 512-bit digest
IPSec DH group	no-pfs	Perfect Forward Secrecy disabled
IPSec lifetime	3600 Seconds	—

Step 1: In **Network > Network Profiles > IKE Crypto**, click **Add**. The IKE Crypto Profile configuration window appears.

Step 2: In the **Name** box, enter **Azure-IKEv2**.

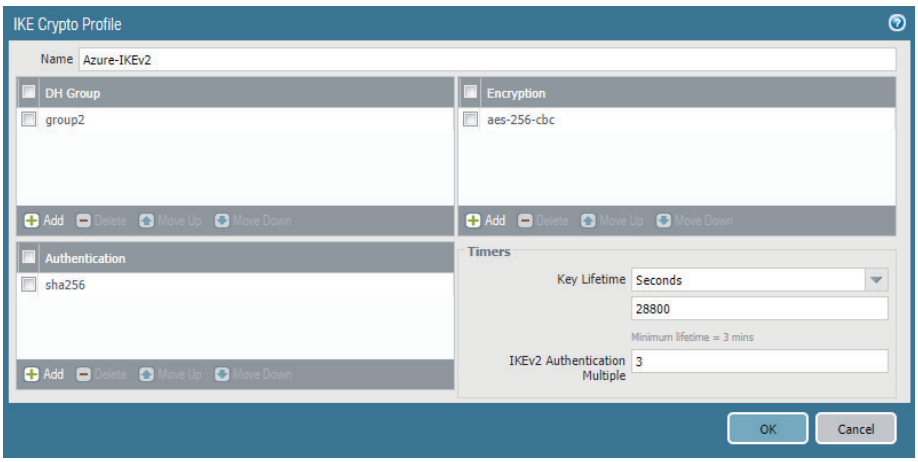
Step 3: In the DH Group pane, click **Add** and select **group2**.

Step 4: In the Authentication pane, click **Add** and select **sha256**.

Step 5: In the Encryption pane, click **Add** and select **aes-256-cbc**.

Step 6: In the Timers section, in the **Key Lifetime** list, select **Seconds** and enter **28800**.

Step 7: In the Timers section, in the **IKEv2 Authentication Multiple** box, enter **3**, and then click **OK**.



Step 8: In **Network > Network Profiles > IPSec Crypto**, click **Add**. The IPSec Crypto Profile configuration window appears.

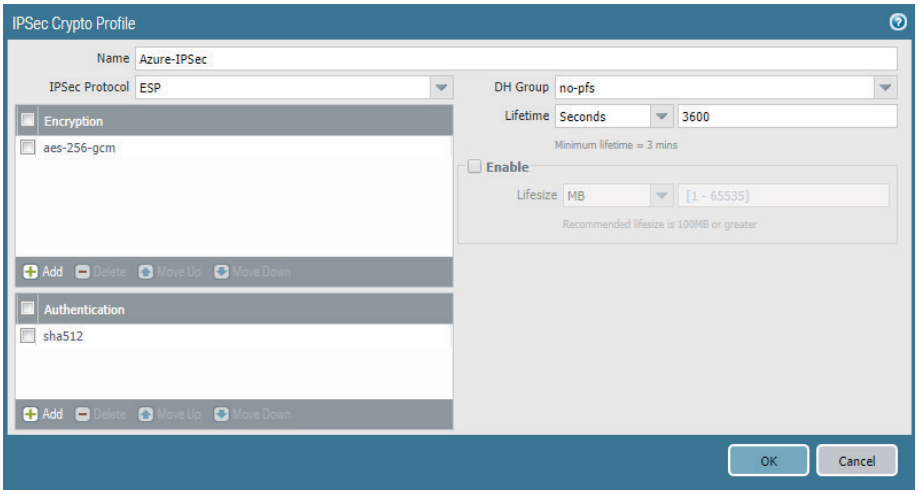
Step 9: In the **Name** box, enter **Azure-IPSec**.

Step 10: In the Encryption pane, click **Add** and select **aes-256-gcm**.

Step 11: In the Authentication pane, click **Add** and select **sha512**.

Step 12: In the **DH Group** list, select **no-pfs**.

Step 13: In the **Lifetime** list, select **Seconds** and enter **3600**, and then click **OK**.



Step 14: In **Network** > **Network Profiles** > **IKE Gateways**, click **Add**. The IKE Gateway configuration window appears.

Step 15: In the **Name** box, enter **OnPrem-to-AzureRefArch-IKEv2**.

Step 16: In the **Version** list, select **IKEv2 only mode**.

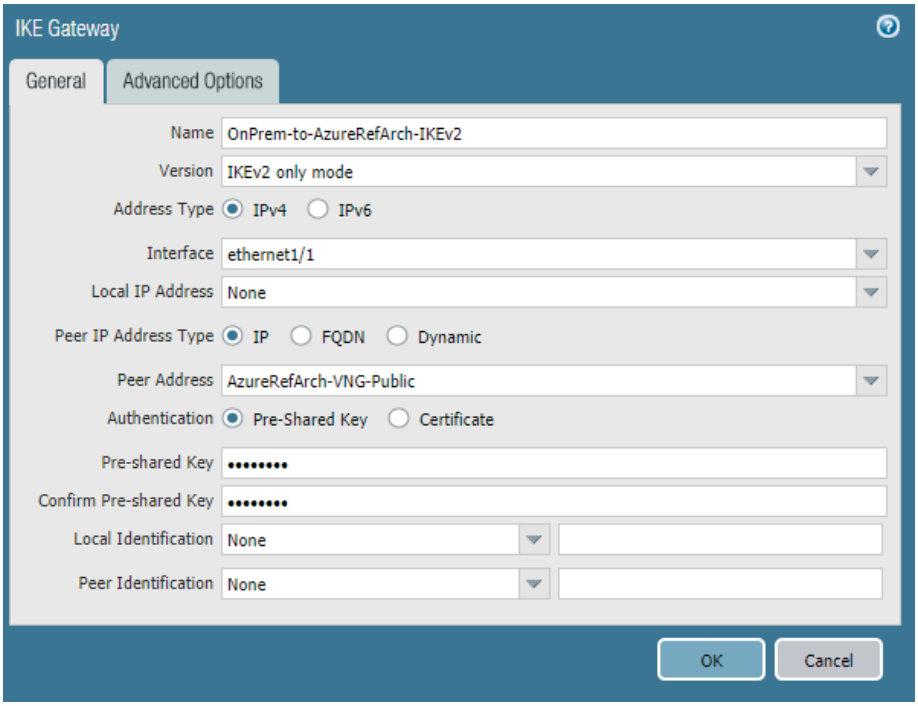
Step 17: In the **Interface** list, select the public interface of the firewall (example: **ethernet1/1**).

Step 18: In the Peer IP Address Type section, select **IP**.

Step 19: In the **Peer Address** list, select **AzureRefArch-VNG-Public**.

Step 20: In the **Pre-shared Key** box, enter the Shared key (PSK) that matches the VPN connection configured on Azure.

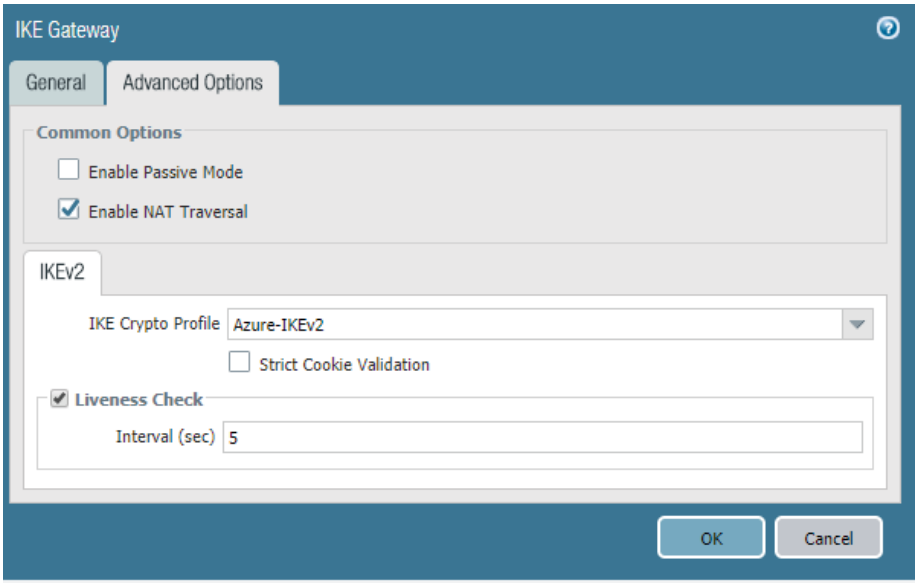
Step 21: In the **Confirm Pre-shared Key** box, re-enter the key.



Step 22: Change to the **Advanced Options** tab.

Step 23: Select **Enable NAT Traversal**.

Step 24: In the **IKE Crypto Profile** list, select **Azure-IKEv2**, and then click **OK**.



Step 25: In **Network** > **IPSec Tunnels**, click **Add**.

Step 26: In the **Name** box, enter **OnPrem-to-AzureRefArch**.

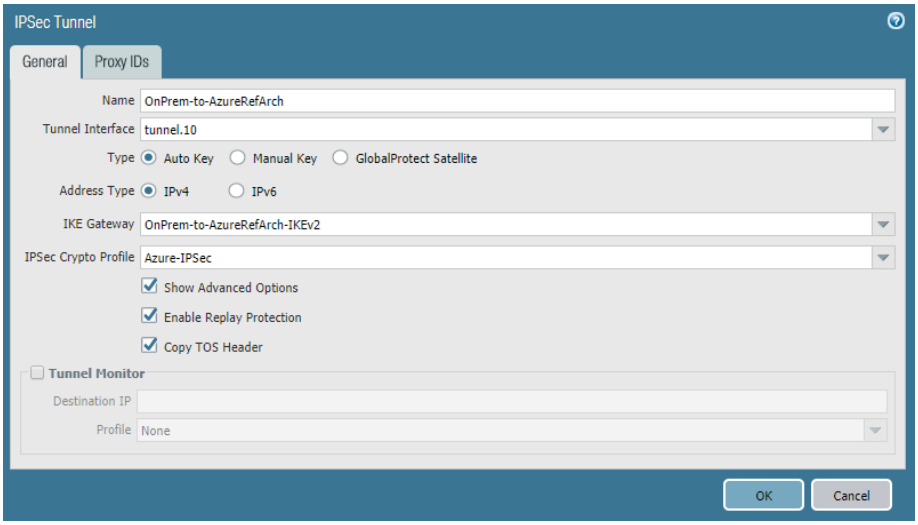
Step 27: In the **Tunnel Interface** list, select **tunnel.10**.

Step 28: In the **IKE Gateway** list, select **OnPrem-to-AzureRefArch-IKEv2**.

Step 29: In the **IPSec Crypto Profile** list, select **Azure-IPSec**.

Step 30: Select **Show Advanced Options**.

Step 31: Select **Copy TOS Header**, and then click **OK**.



10.3 Configure Routing

The static routing option requires the creation of explicit static routes for all Azure destination prefixes. The dynamic routing option requires the creation of a single static route that corresponds to the Azure routing peer prefix. All other destinations are dynamically learned using the routing protocol.

Table 28 Static routes for on premise firewall

Name	Destination prefix	Interface	Next-hop	Next-hop value
Azure-192.168.1.0	192.168.1.0/24	tunnel.10	None	—
Azure-10.5.0.0	10.5.0.0/16	tunnel.10	None	—

Step 1: In **Network > Virtual Routers**, click **default**. The Virtual Router—default window appears.

Step 2: Change to the **Static Routes** tab.

Option 1: Static Routing

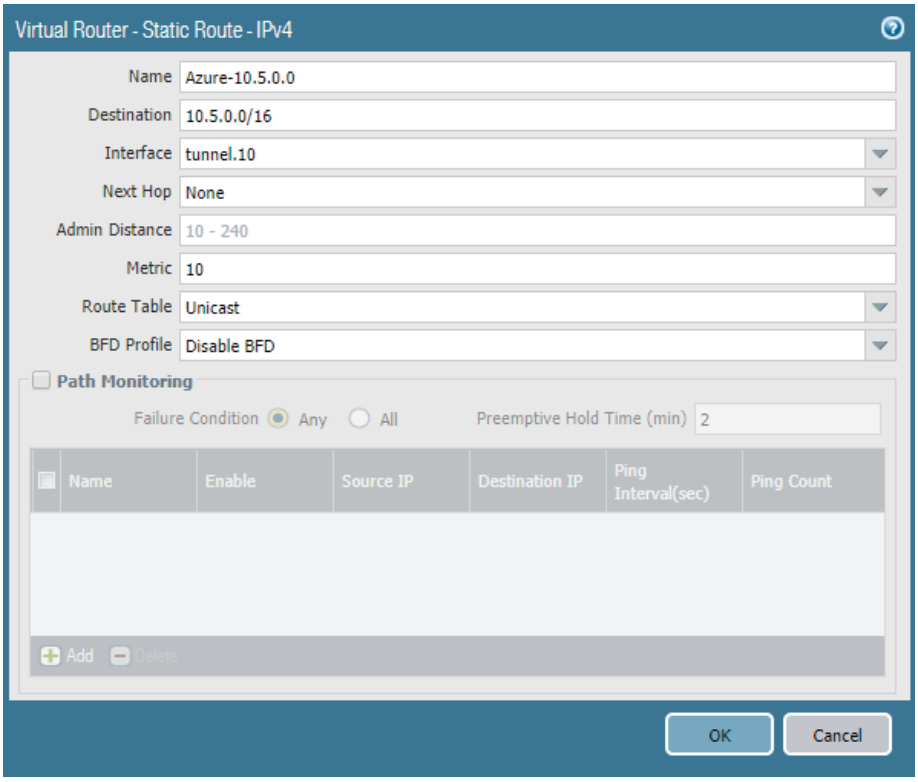
Step 1: Click **Add**. The Virtual Router—Static Route—IPv4 window appears.

Step 2: In the **Name** box, enter **Azure-10.5.0.0**.

Step 3: In the **Destination** box, enter **10.5.0.0/16**.

Step 4: In the **Interface** list, select **tunnel.10**.

Step 5: In the **Next Hop** list, select **None**, and then click **OK**.



Step 6: Repeat Step 1 through Step 5 for all static routes in Table 28.

Step 7: After adding all routes for this virtual router, click **OK** to close the Virtual Router window.

Step 8: Click **Commit**.

Option 2: Dynamic Routing with BGP

The BGP option requires a static host route to reach the Azure BGP peer.

Step 1: Click **Add**. The Virtual Router —Static Route—IPv4 window appears.

Step 2: In the **Name** box, enter **Azure-BGP-Router-ID**.

Step 3: In the **Destination** box, enter **10.5.40.254/32**.

Step 4: In the **Interface** list, select **tunnel.10**.

Step 5: In the **Next Hop** list, select **None**, and then click **OK**.

Step 6: Click **OK** to close the Virtual Router window.

Step 7: Click **Commit**.

10.4 Configure BGP

(Optional)

If you are using static routing, skip this procedure.

This procedure requires that you have a BGP autonomous system number; the example uses 65501 for the on-site firewall. The BGP peering configuration uses the tunnel interface IP address of the firewall as the BGP Router ID.

Step 1: In **Network > Virtual Routers**, click **default**. The Virtual Router—default window appears.

Step 2: Change to the **Redistribution Profile** tab, and click **Add**. The Redistribution Profile IPv4 window appears.

Note

This example redistributes the directly connected route for the subnet assigned to the Private zone interface (ethernet1/2). If you are running a dynamic routing protocol in your on-site network and firewall, then redistribute the routes from the routing protocol instead of the connected route.

The use of a dynamic routing protocol is required to ensure symmetric routing when using a resilient backhaul connection.

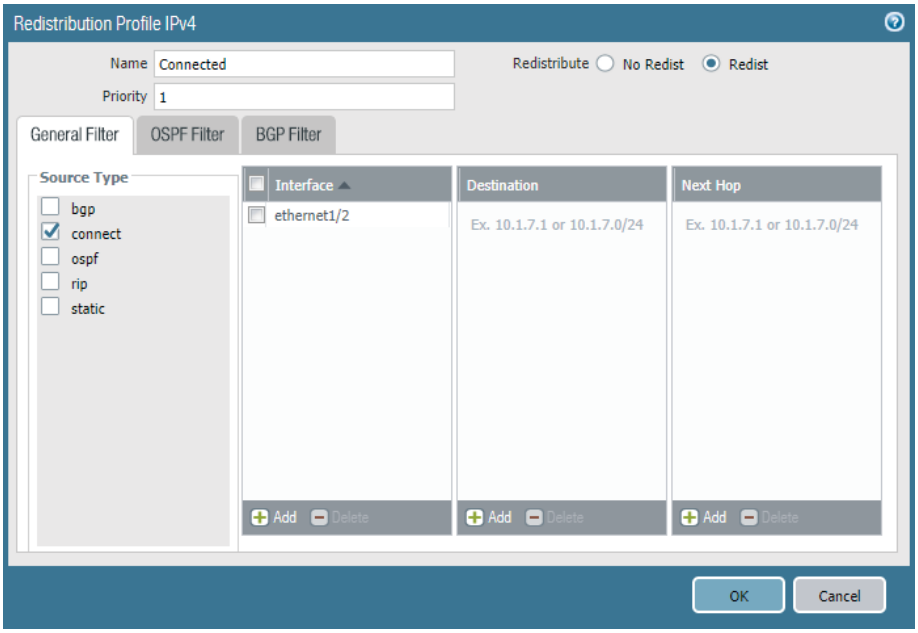
Step 3: In the **Name** box, enter **Connected**.

Step 4: In the Redistribute section, select **Redist**.

Step 5: In the **Priority** box, enter **1**.

Step 6: In the Source Type pane, select **connect**.

Step 7: In the Interface pane, click **Add**, select **ethernet1/2**, and click **OK**.



Step 8: Change to the **BGP** tab.

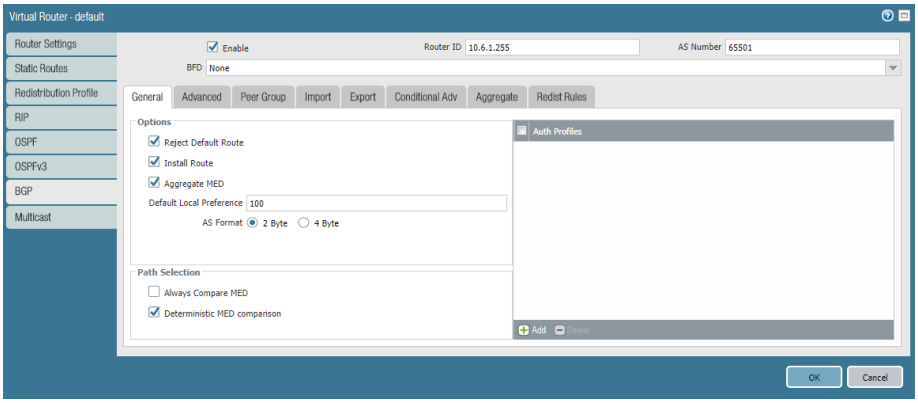
Step 9: Select **Enable**.

> **Note**
>
> If you are configuring the second device for resilient backhaul, use the value of **10.6.1.254** in Step 10.

Step 10: In the **Router ID** box, enter **10.6.1.255**.

Step 11: In the **AS Number** box, enter **65501**.

Step 12: In the Options pane, select **Install Route**.



Step 13: Change to the **Peer Group** tab, and then click **Add**. The Virtual Router—BGP—Peer Group/Peer window appears.

Step 14: In the **Name** box, enter **Azure**.

Step 15: In the Peer pane, click **Add**. The Virtual Router—BGP—Peer Group—Peer window appears.

Step 16: In the **Name** box, enter **AzureRefArch**.

Step 17: In the **Peer AS** box, enter the autonomous system number assigned to the Azure virtual network gateway. The default is **65515**.

Step 18: In the Local Address pane, in the **Interface** list, select **tunnel.10**.

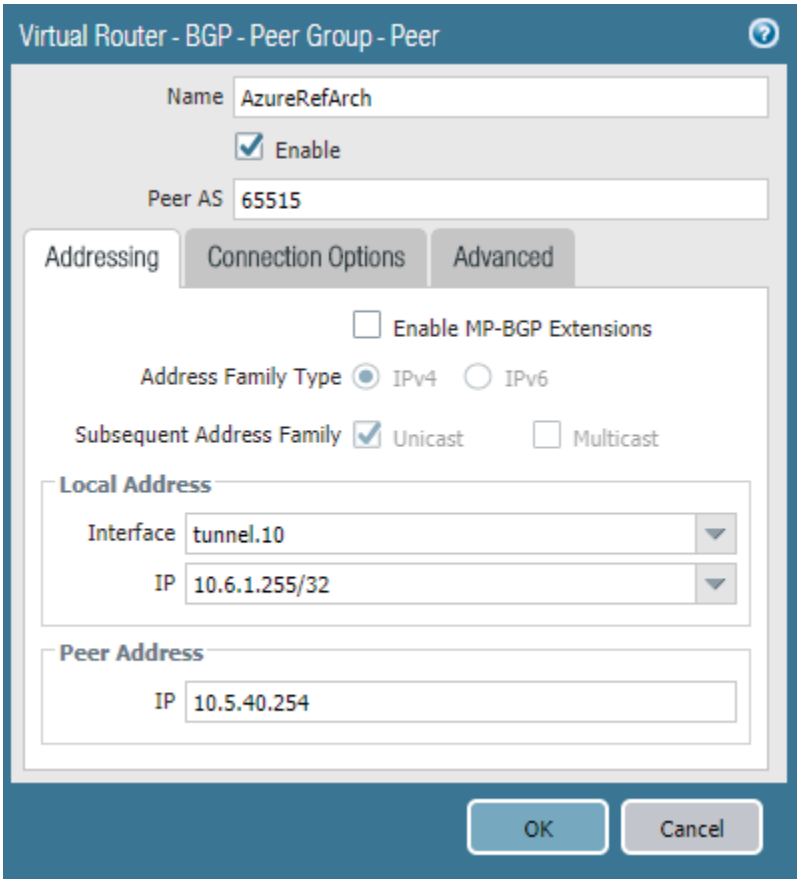
> **Note**
>
> If you are configuring the second device for resilient backhaul, use the value of **10.6.1.254/32** in Step 19.

Step 19: In the Local Address pane, in the **IP** list, select **10.6.1.255/32**.

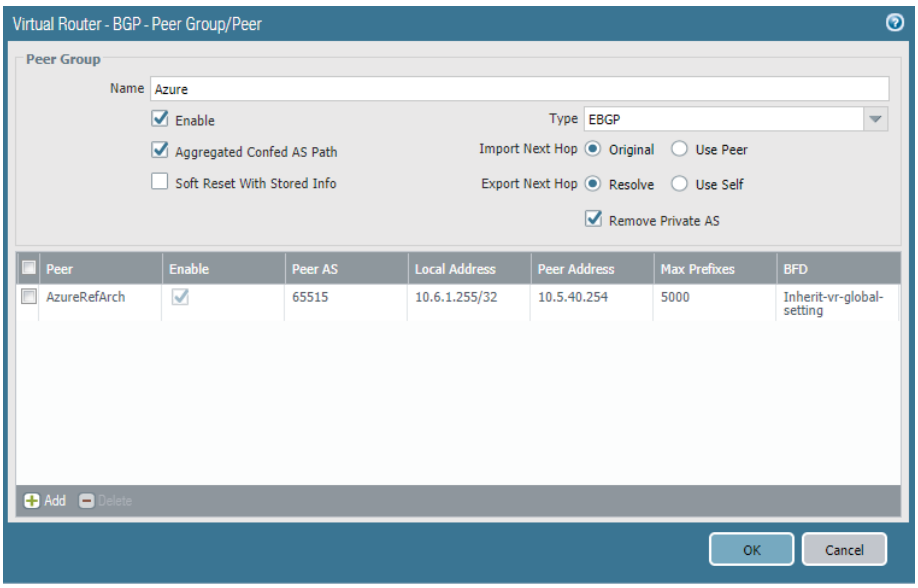
Step 20: In the Peer Address pane, in the **IP** box, enter the BGP peer IP address assigned by Azure to the virtual network gateway (example: **10.5.40.254**).

Step 21: Change to the **Connection Options** tab.

Step 22: In the **Multi Hop** box, enter **2**, and then click **OK**.

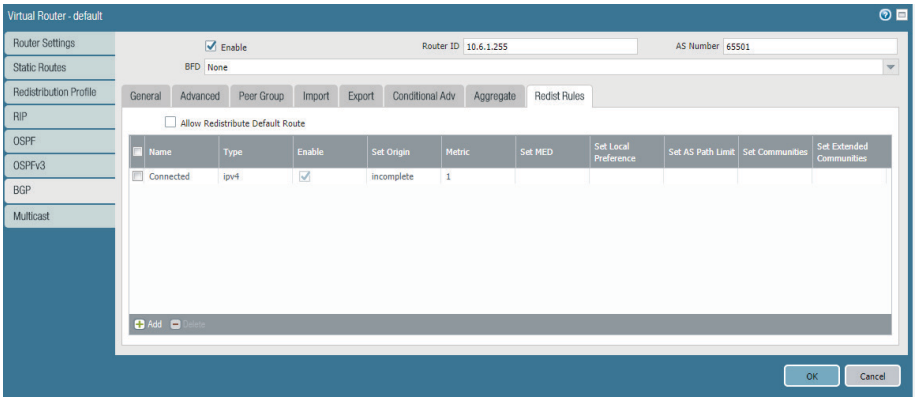


Step 23: Click **OK** to close the Virtual Router—BGP—Peer Group/Peer window.



Step 24: Change to the **Redist Rules** tab, and then click **Add**. The Virtual Router—BGP—Redistribute Rules—Rule window appears.

Step 25: In the **Name** list, select **Connected**, and then click **OK**.



Step 26: Click **OK** to close the Virtual Router—default window.

Step 27: Click **Commit**.

Procedures

Configuring Resilient Backhaul Connection

11.1 Create the Second Local Network Gateway

11.2 Create VPN Connection from VNG to LNG-2

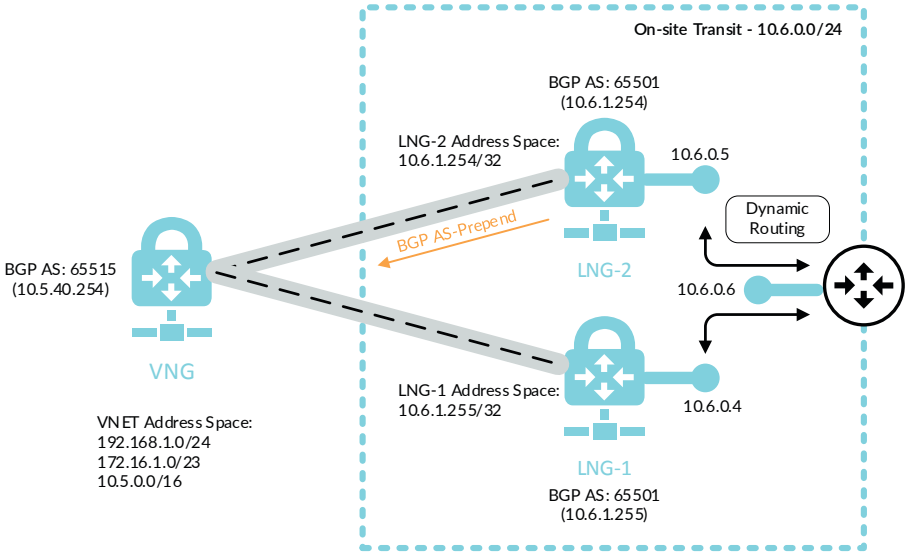
11.3 Configure additional on-site firewall

This procedure group includes the necessary steps to add a second backhaul connection and configure BGP routing for Azure to prefer the first connection if both LNGs are connected. The first connection must already be configured with the BGP routing option.

This procedure relies on the following assumptions:

- The existing on-site firewall BGP peer address (assigned to tunnel interface) is **10.6.2.254**.
- The second existing on-site firewall must have a statically assigned public IP address.
- The on-site network is configured to use dynamic routing between the on-site firewalls and the internal private network. The downstream router learns the Azure routes from both on-site firewalls and is configured to use routing metrics to select the preferred path through the first connection.
- BGP AS-Prepend is used to make the second connection less preferred.

Figure 15 Resilient routing for backhaul connection



11.1 Create the Second Local Network Gateway

The local network gateway corresponds to the second on-premise firewall that terminates the resilient IPSec VPN tunnel from Azure.

Step 1: In **Home > Local network gateways**, click **Add**.

Step 2: In the **Name** box, enter **AzureRefArch-LNG-OnPrem-2**.

Step 3: In the **IP address** box, enter the public IP address of the on-premise IPSec VPN peer (Example: **104.42.56.197**).

Step 4: In the **Address space** box, enter only the IP prefix for the BGP peer address from the on-premise firewall this LNG corresponds to. (Example: **10.6.1.254/32**)

Step 5: Select **Configure BGP settings**.

Step 6: In the **Autonomous system number (ASN)** box, enter **65501**.

Step 7: In the **BGP peer IP address** box, enter **10.6.1.254**.

Step 8: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch**.

Step 9: Click **Create**.

11.2 Create VPN Connection from VNG to LNG-2

Step 1: In **Home > Connections**, click **Add**.

Step 2: In **Home > Connections > Create connection > Basics**, in the **Connection type** list, select **Site-to-site (IPsec)**.

Step 3: In the Resource Group section, choose **Use Existing,** select **AzureRefArch**, and then click **OK**.

Step 4: In **Home > Connections > Create connection > Settings,** click the **Virtual network gateway** section, and then select **AzureRefArch-VNG**.

Step 5: Click the **Local network gateway** section, and then select **AzureRefArch-LNG-OnPrem-2**.

Step 6: In the **Connection name** box, enter **AzureRefarch-to-OnPrem**.

Step 7: In the **Shared key (PSK)** box, enter the value for the pre-shared key (complex password).

Step 8: If you configured BGP, select **Enable BGP**.

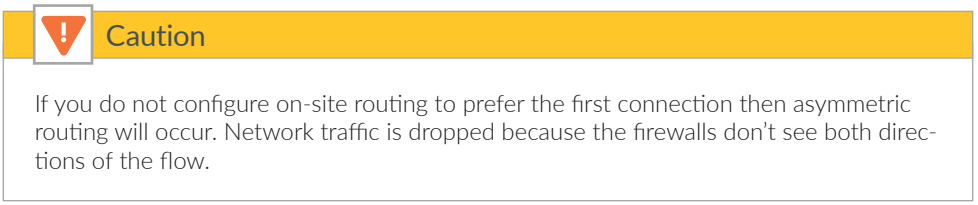
Step 9: Click **OK**.

Step 10: Review the Summary and if acceptable, click **OK**.

11.3 Configure additional on-site firewall

This procedure configures a second on-site firewall to be used for the resilient backhaul connection. After this firewall is configured by repeating earlier procedures, then BGP is configured to make the second connection less preferred.

The BGP configuration prepends a second AS number to the routes advertised from the second firewall. Azure receive all prefixes from both LNGs and uses the AS-path length to make its routing decision. This routing configuration ensures that Azure chooses the first connection when both are available when sending traffic from Azure to the on-site networks. This does not influence the path section in the opposite direction.



Step 1: Repeat Procedure 10.1 through Procedure 10.4 to configure the second firewall using new values as specified in the notes.

Step 2: In **Network > Virtual Routers**, click **default**. The Virtual Router—default window appears.

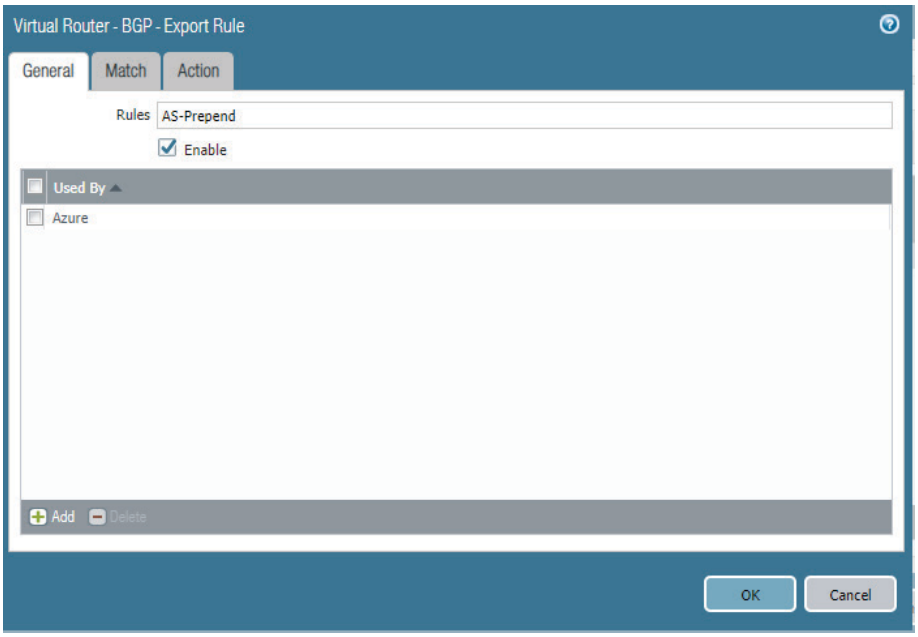
Step 3: Change to the **BGP** tab.

Step 4: Change to the **Export** tab.

Step 5: Click **Add**, The Virtual Router—BGP—Export Rule window appears.

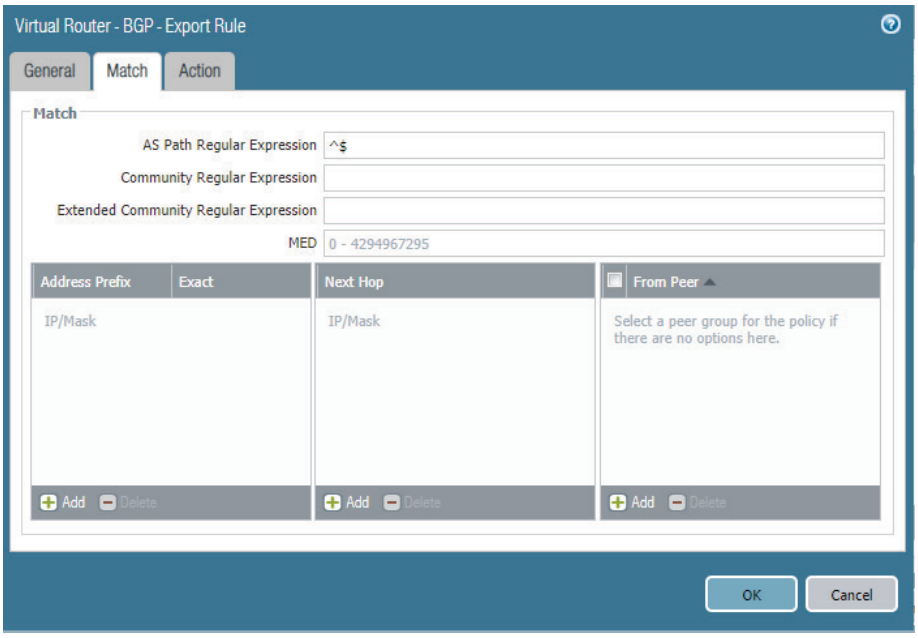
Step 6: In the **Rules** box, enter **AS-Prepend**.

Step 7: In the Used By pane, click **Add**, and select **Azure**.



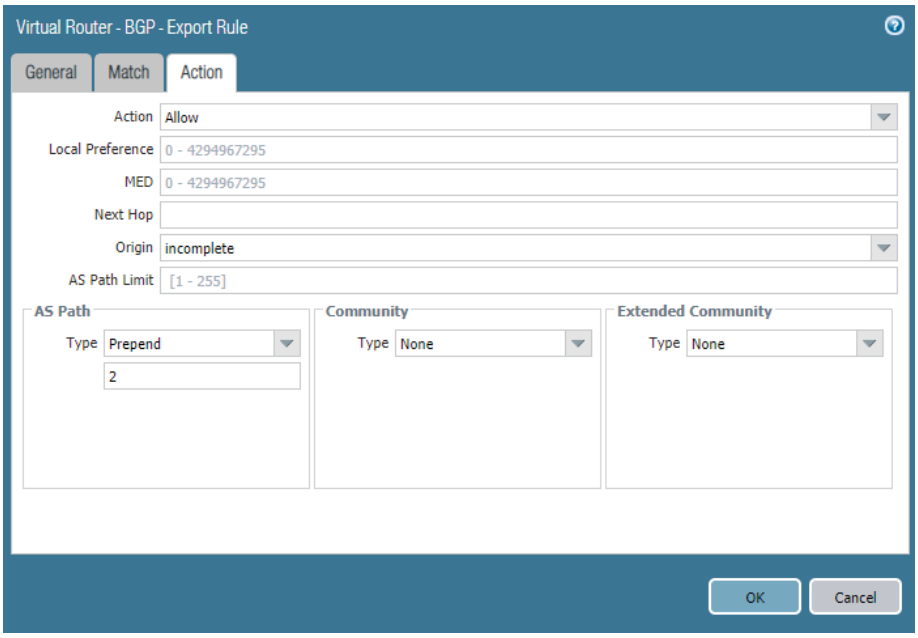
Step 8: Change to the **Match** tab.

Step 9: In the **AS Path Regular Expression** box, enter **^$**. This regular expression matches all prefixes that are local to this autonomous system.



Step 10: Change to the **Action** tab.

Step 11: In the AS Path section, in the **Type** list, select **Prepend**. In the **Type value** box, enter **2**.



Step 12: Click **OK** to close the Virtual Router—BGP—Export Rule window.

Step 13: Click **OK** to close the Virtual Router—default window.

Step 14: Click **Commit**.

Procedures

Using Panorama to Configure Security and NAT for Backhaul Connection

The security policy for the backhaul connection is enforced at multiple locations. The on-site firewall that terminates the VPN tunnel to Azure can use security policy rules between the private zone and the VPN zone. The VM-Series firewalls on Azure can use security policy rules between the VPN zone and the private zone.

Only the VM-Series policy is included in this guide.

12.1 Backhaul Connection—Create Address Objects

This procedure reuses objects already created in Procedure 8.6. If necessary, create additional objects using the same procedure. The table of objects (Table 21) is repeated here.

Table 29 Outbound traffic address objects

Object name	Description	Type	Type value
Net-10.5.1.0	Web subnet	IP Netmask	10.5.1.0/24
Net-10.5.2.0	Business subnet	IP Netmask	10.5.2.0/24
Net-10.5.3.0	DB subnet	IP Netmask	10.5.3.0/24

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups > Objects**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups > Objects > Addresses**, click **Add**.

Step 5: In the **Name** box, enter **Net-10.6.0.0**.

Step 6: In the **Type** list, select **IP Netmask**.

Step 7: In the **Type value** box, enter **10.6.0.0/16**, and then click **OK**.

12.2 Backhaul Connection—Configure NAT Policy

This procedure uses NAT Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device.

Step 1: Log in to Panorama (example: https://ara-panorama-1.westus.cloudapp.azure.com).

Step 2: Navigate to **Device Groups > Policies**.

Step 3: In the **Device Group** list, select **Azure-Shared**.

Step 4: In **Device Groups > Policies > NAT > Pre Rules**, click **Add**.

Step 5: In the **Name** box, enter **VPN-to-Private**.

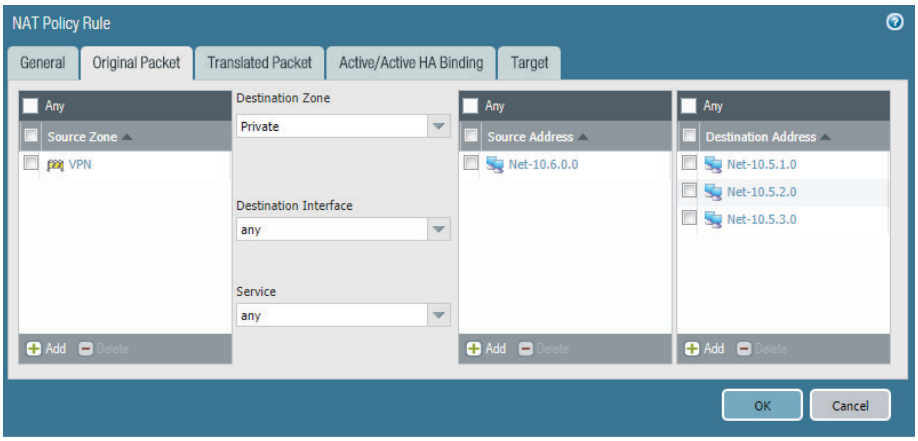
Step 6: Change to the **Original Packet** tab.

Step 7: In the Source Zone pane, click **Add** and select **VPN**.

Step 8: In the Destination Zone list, select **Private**.

Step 9: In the Source Address pane, click **Add** and select **Net-10.6.0.0**.

Step 10: In the Destination Address pane, click **Add** and select **Net-10.5.1.0**. Repeat this step for all objects in Table 29.

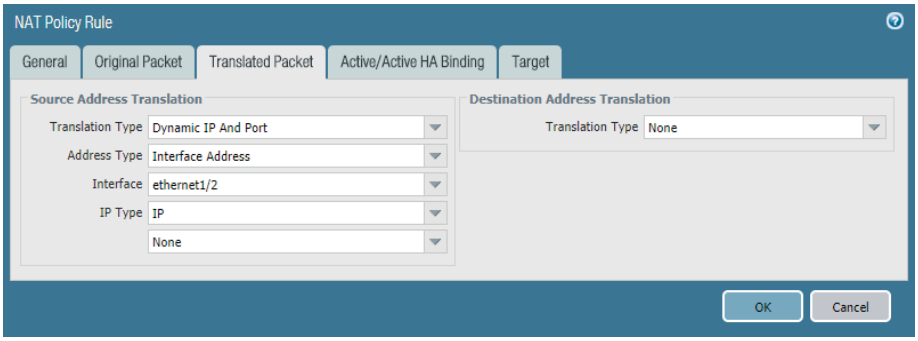


Step 11: Change to the **Translated Packet** tab.

Step 12: In the Source Address Translation section, in the **Translation Type** list, select **Dynamic IP And Port**.

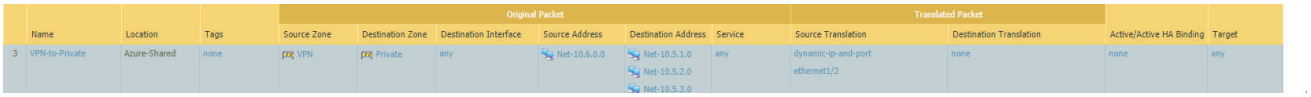
Step 13: In the Source Address Translation section, in the **Address Type** list, select **Interface Address**.

Step 14: In the Source Address Translation section, in the **Interface box**, enter **ethernet1/2**.



Step 15: Change to the **Target** tab.

Step 16: Verify that **Any (target to all devices)** is selected.



	Name	Location	Tags	Original Packet						Translated Packet			
				Source Zone	Destination Zone	Destination Interface	Source Address	Destination Address	Service	Source Translation	Destination Translation	Active/Active HA Binding	Target
3	VPN-to-Private	Azure-Shared	none	VPN	Private	any	Net-10.6.0.0	Net-10.5.1.0 Net-10.5.2.0 Net-10.5.3.0	any	dynamic-ip-and-port ethernet1/2	none	none	any

> **Caution**
>
> Make sure to target all devices in the device group; otherwise, the policy rule will not be automatically applied to new group members.

12.3 Backhaul Connection—Configure Security Policy

This procedure uses Security Pre Rules. These rules are logically evaluated prior to local rules and cannot be locally overridden on the local device.

The security policy example for the Backhaul Connection Profile permits these applications:

- SSH (ssh)
- RDP (ms-rdp)
- web-browsing

Add additional required applications to your policy as needed.

Step 1: In **Device Groups > Policies > Security > Pre Rules**, click **Add**.

Step 2: In the **Name** box, enter **VPN-to-Private**.

Step 3: Change to the **Source** tab.

Step 4: In the Source Zone pane, click **Add** and select **VPN**.

Step 5: In the Source Address pane, click **Add** and select **10.6.0.0**.

Step 6: Change to the **Destination** tab.

Step 7: In the Destination Zone pane, click **Add** and select **Private**.

Step 8: In the Destination Address pane, click **Add** and select **10.5.1.0**. Repeat this step for all objects in Table 29.

Step 9: Change to the **Application** tab.

Step 10: In the Applications pane, click **Add** and enter/search/select **ssh**

Step 11: In the Applications pane, click **Add** and enter/search/select **ms-rdp**.

Step 12: In the Applications pane, click **Add** and enter/search/select **web-browsing**.

Step 13: Change to the **Service/URL Category** tab.

Step 14: In the Service pane, select **application-default**.

Step 15: Change to the **Actions** tab.

Step 16: In the Action Setting section, in the **Action** list, select **Allow**.

Step 17: In the Log Setting section, in the **Log Forwarding** list, select **LoggingService-Profile**.

Step 18: Change to the **Target** tab.

Step 19: Verify that **Any (target to all devices)** is selected, and then click **OK**.

> **Caution**
>
> Make sure to target all devices (any) in the device group; otherwise, the policy rule will not be automatically applied to new group members.

				Source		Destination							
	Name	Location	Type	Zone	Address	Zone	Address	Application	Service	Action	Profile	Options	Target
4	VPN-to-Private	Azure-Shared	universal	VPN	Net-10.6.0.0	Private	Net-10.5.1.0 Net-10.5.2.0 Net-10.5.3.0	ms-rdp ssh web-browsing	application-default	Allow	none		any

Step 20: On the **Commit** menu, click **Commit and Push**.

Deployment Details for Automated Bootstrapping

Procedures

This procedure group provides an alternate deployment method to Procedure 4.1. In addition to deploying the VM-Series using the ARM template, the automated bootstrap process licenses the VM-Series and registers the VM-Series device with Panorama with the designated templates and device group. This option would not typically be chosen to deploy the initial devices, but it is an effective option for scaling performance by adding additional firewalls after the first pair have been deployed.

After deployment using the bootstrap, a new VM-Series is added to the Azure public and internal load-balancers back-end pools to complete the integration and make the VM-Series active.

13.1 Create the Bootstrap Package

Step 1: Generate VM Auth Key on Panorama.

The next step requires the use of the command line. (You can also do it via API, but that option is not covered by this guide.)

Step 2: Using SSH, log in to the Panorama command line.

Step 3: Request the VM auth key by using the following command. The lifetime of the key can vary between 1 hour and 8760 hours (1 year). After the specified time, the key expires. Panorama does not register VM-Series firewalls without a valid auth-key in the connection request.

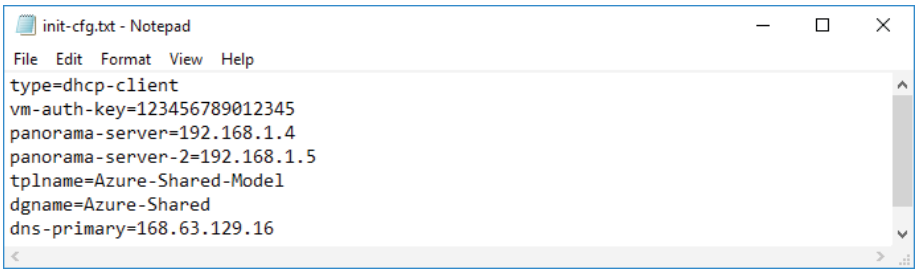
```
request bootstrap vm-auth-key generate lifetime 8760

VM auth key 123456789012345 generated. Expires at: 2019/06/07 14:15:56
```

Step 4: Create init-cfg.txt file.

The following table includes the parameters required for successful bootstrap on Azure. The VM-Series registers with Panorama and is assigned to the listed template stack and device group. Create the file by using a text editor and save as init-cfg.txt

Table 30 Required parameters for Azure bootstrap

Description	Parameter	Value
Type of management IP address	type	dhcp-client
Virtual machine authentication key	vm-auth-key	(generated on Panorama)
Panorama IP address	panorama-server	192.168.1.4
Panorama IP address (secondary)	panorama-server-2 (optional for H/A only)	192.168.1.5 (optional for H/A only)
Template stack name	tplname	Azure-Shared-Model
Device group name	dgname	Azure-Shared



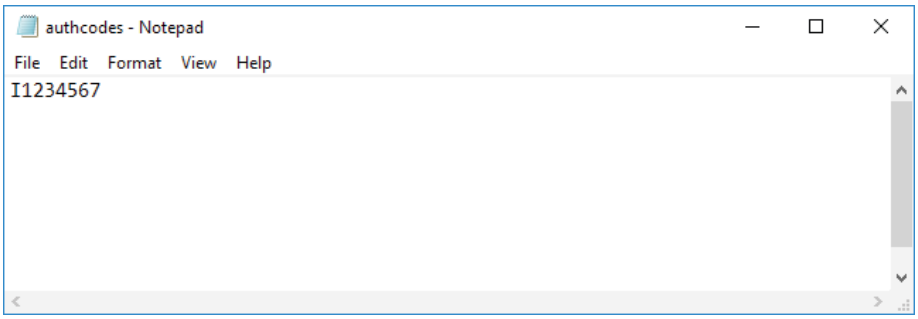
Step 5: If you are using BYOL, create the authcodes file. An auth code bundle includes all of the VM-Series feature licenses with a single auth code.

Example: **I1234567**

Caution

The filename for the authcodes file must not include any extension such as .txt. If you save the file with an extension, the bootstrap process fails.

Create the file using a text editor and save as **authcodes**.

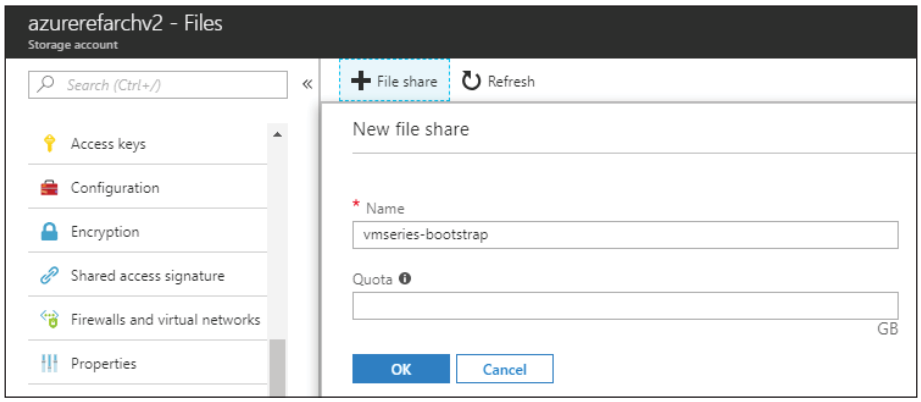


13.2 Deploy the Bootstrap Package to Azure Storage

This procedure creates a new file share for the bootstrap package in an existing storage account.

Step 1: In **Home** > **Storage accounts** > **azurerefarchv2** > **FILE SERVICE** > **Files**, click **File share**.

Step 2: In the **Name** box, enter **vmseries-bootstrap**, and click **OK**.



Step 3: In **Home** > **Storage accounts** > azurerefarchv2 > **FILE SERVICE** > **Files**, click **vmseries-bootstrap**.

Table 31 Bootstrap package structure

Directory name	File
config	init-cfg.txt
content	—
license	authcodes
software	—

Step 4: Click **Add directory**.

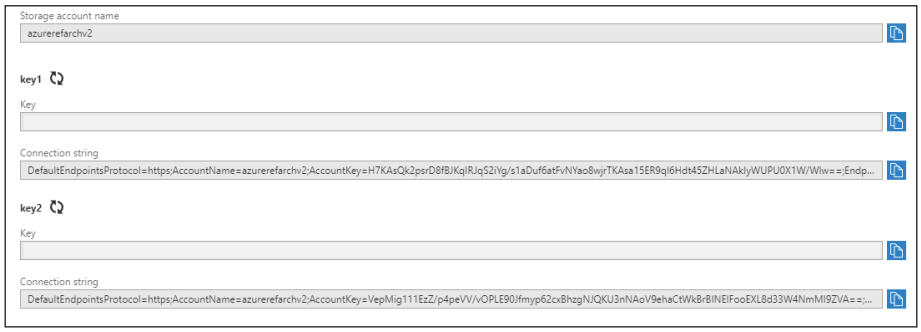
Step 5: In the **Name** box, enter **config**, and then click **OK**.

Step 6: If a **File** is listed for a corresponding directory in Table 31, then complete these substeps for the file:

- Click **config**.
- Click **Upload**.
- In the Upload files pane, browse to your local filesystem and select **init-cfg.txt**.
- Click **Upload**.

Step 7: Repeat Step 4 through Step 6 for each entry in Table 31.

Step 8: In **Home > Storage accounts > azurerefarchv2 > FILE SETTINGS > Access keys**, record the access key for the storage account (either key1 or key2) by using **Click to copy**.



Note

You will need to provide the Storage Account, valid Storage Account access key, and File Share at deployment time.

Example:

Storage Account Name: azurerefarchv2
Access Key: <key>
File Share Name: vmseries-bootstrap

13.3 Create the Public IP Address for VM-Series

This procedure is identical to Procedure 3.6. It is repeated here for completeness.

The VM-Series devices deployed on Azure are managed using public IP addresses unless on-site network connectivity has been established. The process to configure on-site network connectivity is included later in this guide.

This procedure creates a public IP address that is associated to the management interface of the VM-Series at deployment time. If necessary, this procedure is repeated to create additional public IP addresses for additional VM-Series devices. The parameters listed in Table 4 are used to complete this procedure.

Take note of the fully qualified domain name (FQDN) that is defined by adding the location specific suffix to your DNS name label. We recommend managing your devices using the DNS name rather than the public IP address, which may change.

Step 1: In **Home > Public IP addresses**, click **Add.**

Step 2: In the **Name** box, enter **aras-vmfw3**.

Step 3: Select **Standard** SKU.

Step 4: In the **DNS name label** box, enter **aras-vmfw3**.

Step 5: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 6: Click **Create**.

Procedures

Deploying the VM-Series with Bootstrap

14.1 Deploy the VM-Series

14.2 Add VM-Series to Load-Balancer Backend Pools

The following procedures are completed using the Azure Resource Manager deployed from an Azure Resource Manager Template posted at GitHub. If you are already signed in to Azure at https://portal.azure.com, then the deployment from GitHub uses the same session authorization.

14.1 Deploy the VM-Series

This procedure is essentially identical to Procedure 4.1, with additional steps to provide the bootstrap information.

Table 32 VM-Series bootstrap deployment parameters

Parameter	Value	Comments
Resource group	AzureRefArch-Shared	Existing
Location		Tested in West US
VM name	ARAS-VMFW3	First bootstrap device. Assumes two firewalls already deployed
Storage account name	azurerefarchv2shared	—
Storage account existing RG	AzureRefArch-Shared	—
Fw Av set	AzureRefArch-Shared-AS	—
VM size	Standard_D3_v2	https://www.paloaltonetworks.com/documentation/80/virtualization/virtualization/set-up-the-vm-series-firewall-on-azure/about-the-vm-series-firewall-on-azure/minimum-system-requirements-for-the-vm-series-on-azure
Public IP type	standard	Standard IP SKU required for use with Azure Standard load-balancer
Image version	latest	—
Image Sku	byol	—
Bootstrap firewall	yes	—
Bootstrap storage account	azurerefarchv2	The bootstrap storage account may be in any resource group within the same Azure subscription and location.
Storage account access key	<key>	Use value recorded from Procedure 13.2, Step 8
Storage account file share	vmseries-bootstrap	Created in Procedure 13.2
Virtual network name	AzureRefArch-VNET	Uses AzureRefArch-VNET in resource group AzureRefarch
Virtual network address prefix	192.168.1.0/24	Match the initial IP address space from AzureRefArch-VNET
Virtual network existing RG name	AzureRefArch	—
Subnet0Name	Management	—
Subnet1Name	Shared-Public	—
Subnet2Name	Shared-Private	—
Subnet3Name	Shared-VPN	—

Table continued on next page

Continued table

Parameter	Value	Comments
Subnet0Prefix	192.168.1.0/24	—
Subnet1Prefix	172.16.1.0/24	—
Subnet2Prefix	10.5.0.0/24	—
Subnet3Prefix	10.5.15.0/24	—
Subnet0Start Address	192.168.1.8	First bootstrap device
Subnet1Start Address	172.16.1.8	First bootstrap device
Subnet2Start Address	10.5.0.8	First bootstrap device
Subnet3Start Address	10.5.15.8	First bootstrap device.
Admin username	refarchadmin	—
Admin password	<password>	—
Public IP address name	aras-vmfw3	First bootstrap device
Nsg name	None	NSG is applied at subnet level

The custom Azure Resource Manager template used in this procedure has been developed and validated specifically for this deployment guide.

For template details and features, see :
https://github.com/PaloAltoNetworks/ReferenceArchitectures/tree/master/Azure-1FW-4-interfaces-existing-environment-BS

Use the parameters in Table 32 to deploy each VM-Series with bootstrap configuration.

Step 1: Deploy the VM-Series by clicking **Deploy to Azure**.

Step 2: In the Resource Group section, choose **Use Existing,** and then select **AzureRefArch-Shared**.

Step 3: In the **Vm Name** box, enter **ARAS-VMFW3**.

Step 4: In the **Storage Account Name** box, enter **azurerefarchv2shared**.

Step 5: In the **Storage Account Existing RG** box, enter **AzureRefArch-Shared**.

Step 6: In the **Fw Av Set** box, enter **AzureRefArch-Shared-AS**.

Step 7: In the **Vm Size** list, select **Standard_D3_v2**.

Step 8: In the **Public IP Type** list, select **standard**.

Step 9: In the **Image Version** list, select **latest**.

Step 10: In the **Image Sku** list, select **byol**.

Step 11: In the **Bootstrap Firewall** list, select **yes**.

Step 12: In the **Bootstrap Storage Account** box, enter **azurerefarchv2**.

Step 13: In the **Storage Account Access Key** box, enter the key value.

Step 14: In the **Storage Account File Share** box, enter **vmseries-bootstrap**.

Step 15: In the **Virtual Network Name** box, enter **AzureRefArch-VNET**.

Step 16: In the **Virtual Network Address Prefix** box, enter **192.168.1.0/24**.

Step 17: In the **Virtual Network Existing RG Name** box, enter **AzureRefArch**.

Step 18: In the **Subnet0Name** box, enter **Management**.

Step 19: In the **Subnet1Name** box, enter **Shared-Public**.

Step 20: In the **Subnet2Name** box, enter **Shared-Private**.

Step 21: In the **Subnet3Name** box, enter **Shared-VPN**.

Step 22: In the **Subnet0Prefix** box, enter **192.168.1.0/24**.

Step 23: In the **Subnet1Prefix** box, enter **172.16.1.0/24**.

Step 24: In the **Subnet2Prefix** box, enter **10.5.0.0/24**.

Step 25: In the **Subnet3Prefix** box, enter **10.5.15.0/24**.

Step 26: In the **Subnet0Start Address** box, enter **192.168.1.8**.

Step 27: In the **Subnet1Start Address** box, enter **172.16.1.8**.

Step 28: In the **Subnet2Start Address** box, enter **10.5.0.8**.

Step 29: In the **Subnet3Start Address** box, enter **10.5.15.8**.

Step 30: In the **Admin Username** box, enter **refarchadmin**.

Step 31: In the **Admin Password** box, enter the password.

Step 32: In the **Public IP Address Name** box, enter **aras-vmfw3**.

Step 33: In the **Network Security Group** box, enter **None**.

Step 34: Review the terms and conditions. If they are acceptable, select **I agree to the terms and conditions**.

Step 35: Click **Purchase**.

After deployment, the device registers with Panorama by using the provided bootstrap information. The device is automatically licensed using the bundled auth-code in the bootstrap package. After the services are restarted, the device receives template and device group configuration from Panorama and is ready to be managed.

The software should be upgraded to the same version as other VM-Series firewalls. This procedure is identical to Procedure 4.3 in this guide.

14.2 Add VM-Series to Load-Balancer Backend Pools

You already created the public and private load-balancers in Procedure 7.2 and Procedure 7.4, as well as performing other configurations and updates throughout the guide. Now you integrate additional firewall resources into the design by adding the VM-Series devices to the load-balancer backend pools.

This procedure only includes the steps to add an additional VM-Series device to existing backend pools. Repeat this procedure for each VM-Series device as required.

Step 1: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Public**, click **Backend pools**.

Step 2: Click **Firewall-Layer**.

Step 3: In the **VIRTUAL MACHINE** column, in the first blank row, select a VM-Series to be added to this backend pool (example: **aras-vmfw3**).

Step 4: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Public** subnet. (example: **ipconfig-untrust**).

Step 5: Click **Save**, and then click **X** to exit.

Step 6: In **Home** > **Load Balancers** > **AzureRefArch-Shared-Internal**, click **Backend pools**.

Step 7: Click **Internal-Firewall-Layer**.

Step 8: In the **VIRTUAL MACHINE** column, in the first blank row, select a VM-Series to be added to this backend pool (example: **aras-vmfw3**).

Step 9: In the **IP ADDRESS** column, select the **IP configuration** that is associated to the **Shared-Private** subnet. (example: **ipconfig-trust**).

Step 10: Click **Save**, and then click **X** to exit.

Step 11: If you have additional backend pools for your internal load-balancer for Inbound Access and Backhaul and Management traffic, then repeat Step 6 through Step 10 for the **Public-Firewall-Layer** backend pool on the **Shared-Public** subnet and the **VPN-Firewall-Layer** backend pool on the **Shared-VPN** subnet.

What's New in This Release

Palo Alto Networks made the following changes since the last version of this guide:

- This is a new guide.

You can use the feedback form to send comments about this guide.

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